Waterways Design Tool

May 18, 2008

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1. Stability Design of Grass-Lined Waterways

Waterway Design Tool (WDT) assists users in sizing grassed waterways, unlined waterways, and diversions according to the methodology presented in USDA Agricultural Research Service Agricultural Handbook Number 667: Stability Design of Grass-Lined Open Channels. Users can design waterways with or without the aid of detailed survey information and using trapezoidal, parabolic, or triangular shaped waterways in addition to diversions. Note: This section of the help system begins at the point when a new Waterway Manager is created. Please refer to the **Engineering Field Tools Framework** section of the **Help** system for assistance in adding Customer and adding Projects.

2. Overview

The Waterway Design Tool (WDT) can be used as a simple calculator for sizing a grassed waterway, earth-lined channel, or a diversion. You have the option not using survey information (simple case waterway) or of using survey input that is in XYZ format, Station Offset format, or Radial Survey format. A waterway can be started with as little information as the waterway slope or can be drawn on a topographic map using a survey map alignment tool. Users can use topographic maps which have been created using the Survey Engineering Tool (SET) or can

create the topographic surface within WDT. Users must enter information on the channel shape, design flow, soil and vegetation characteristics. In the future, tools will be added to EFT which will allow users to calculate design flow, but that option is currently not available. WDT also has a flexible report generation tool which allows users to create a report that includes detail sheets as well as other user defined standard sheets.

3. Engineering Field Tools (EFT) Framework

The Engineering Field Tools (EFT) Framework is an application platform that coordinates a variety of software tools that enable engineering practices. The primary management interface to these tools is the EFT Overview. The Overview gives a snapshot of all customers, projects, and managers or tools available for use within EFT. The Overview interface consists of a Tree Area which shows an expandable list of Customers and associated Projects, and a Contents Area which gives a summary of the selected item. The Overview operates primarily on local EFT Customers, working with any number of their projects and sets of data (managers). Additionally, if you have NRCS's Customer Service Toolkit (Toolkit) installed, Overview can work with Toolkit Customers. These Toolkit Customers are treated separately and shown in their own tree in the Tree Area. You do not need to have Toolkit installed to work with EFT. Working with Customers and Projects is explained further in the Engineering Field Tools (EFT) Framework Help.

4. Multiple Waterways or Diversions and Laterals

The Waterway Design Tool (WDT) can print multiple waterways, diversions, and eventually other EFT tool output such as SET together in the same output report. WDT can print multiple waterway managers together as long as they are within the same Project file. For more help on Customers and Projects, see the help for EFT Framework. Each Customer can have multiple Projects. Each Project can have multiple SET surveys, WDT waterway managers, and eventually other tools as well. For a waterway which has a lateral, the main waterway should be handled with one waterway manager and the lateral handled with another waterway manager. Be sure that you use a waterway manager name that will allow you to be able to identify which part of the waterway you are working on. If you have a field with multiple waterways and you want the report for each of those waterways to be in the same report, you can accomplish this by having multiple waterways within the same project. Additionally, if you have a waterway that is very long, it may be desirable to break this waterway into multiple waterway managers. This will allow the user more flexibility in handling different aspects of a waterway such as breaking a long profile into multiple profiles.

5. Waterway Manager

A Manager is an engineering software application, such as the Survey Engineering Tool or the Waterway Design Tool. Waterway Manager contains all the data relevant to a single waterway which may have multiple reaches. Waterway branches will need to be handled using separate waterway managers. Multiple waterway managers can be printed at the same time as long as each waterway manager is within the same Project. See the Engineering Field Tools Framework section of the Help system for more information on Customers and Projects. Additionally, long waterways may need to be broken into more than one waterway manager if the profile resolution gets too small (See the section on Printing Waterway Profile Reports).

There are three methods of opening a waterway manager from within Engineering Field Tools (EFT). You can open a new waterway from the top-level interface which will trigger an input wizard, open a new waterway manager from within the customer window, or open an existing waterway from within the customer window.

5.1. New Waterway Manager Wizard

The first method would be to use the **New Waterway Manager** wizard from the top-level interface.

Upon selecting the New Waterway Manager Wizard, Waterway Design Tool (WDT) will walk you through the process of creating a new waterway. You will be prompted as follows:

1. Select the name of the customer you will be working for or enter a new Customer Name.

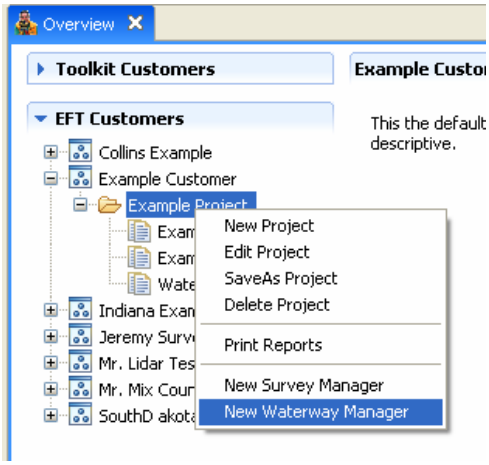
2. Select name of the project you will be working on or enter a new Project Name.

3. Enter the name of the new Waterway Manager.

After completing this process the Waterway Manager will be opened, ready for data input.

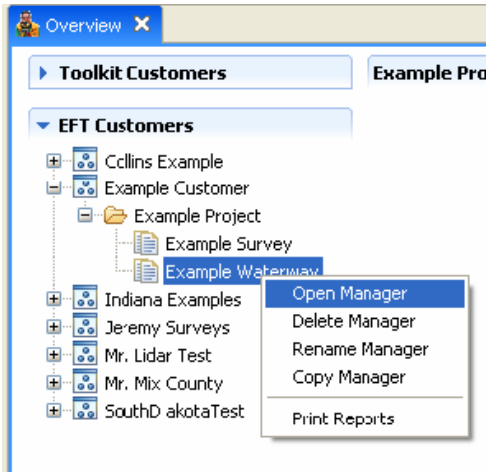
5.2. Customer Window New Waterway Manager

The second option for opening a new waterway manager would be to select a customer and project from within the customer window, right click on the project, and select **New Waterway Manager** from the pop-up window. After selection, you will be prompted to enter a waterway manager name followed by the Waterway Manager being opened, ready for data input.



5.3. Open Existing Waterway Manager

The third option for opening a waterway is within the customer window, either double click on the name of an existing waterway manager or right click on the name of a waterway manager and choose **Open Manager** from the pop-up window.



5.4. Copy Existing Waterway Manager

Copying of a waterway manager can be very useful. An example would be having a waterway which has a lateral. Each Waterway Manager can only have one alignment. After entering data for the main branch of a waterway,

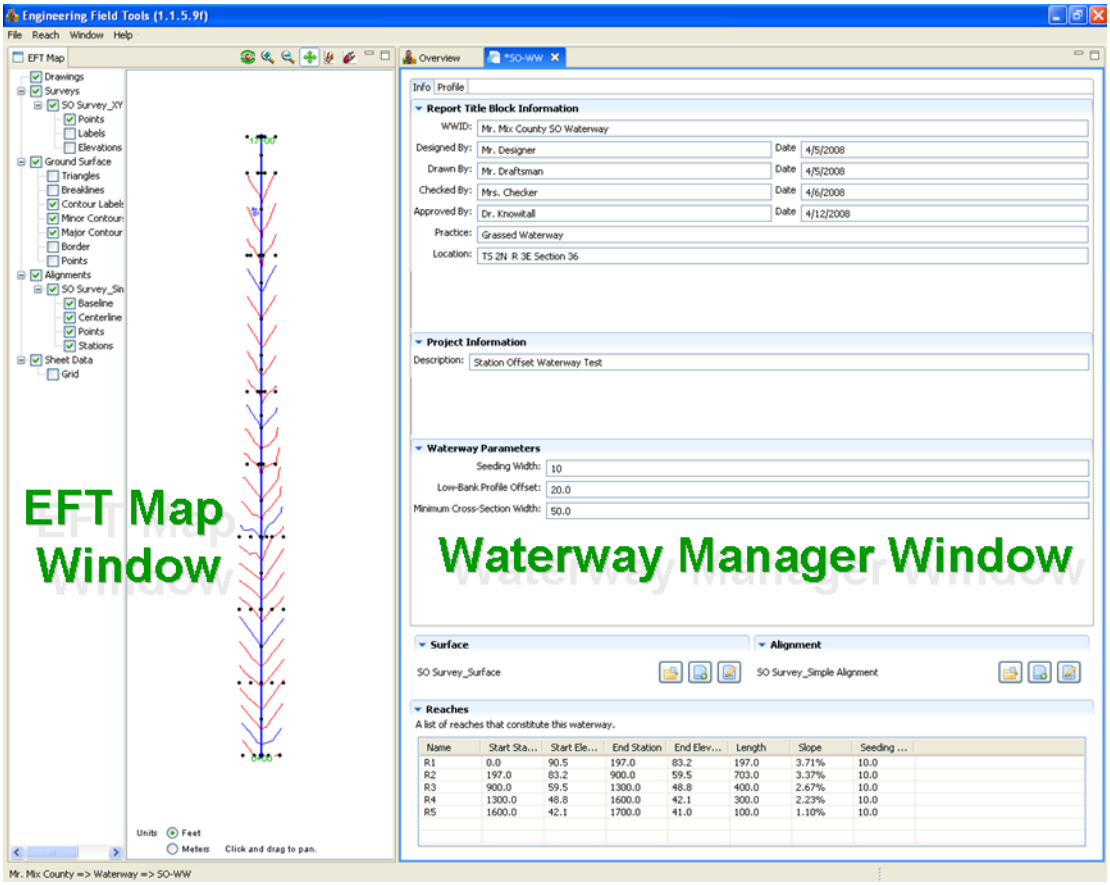
you may find that the data entry required for editing a copy of the existing waterway would be less than creation of a new waterway manager.

5.5. Delete and Rename Existing Waterway Manager

As the name implies, the delete and rename existing waterway manager options allows waterway managers to be deleted or renamed. **Once a waterway manager has been deleted, there is no way to undo the deletion.**

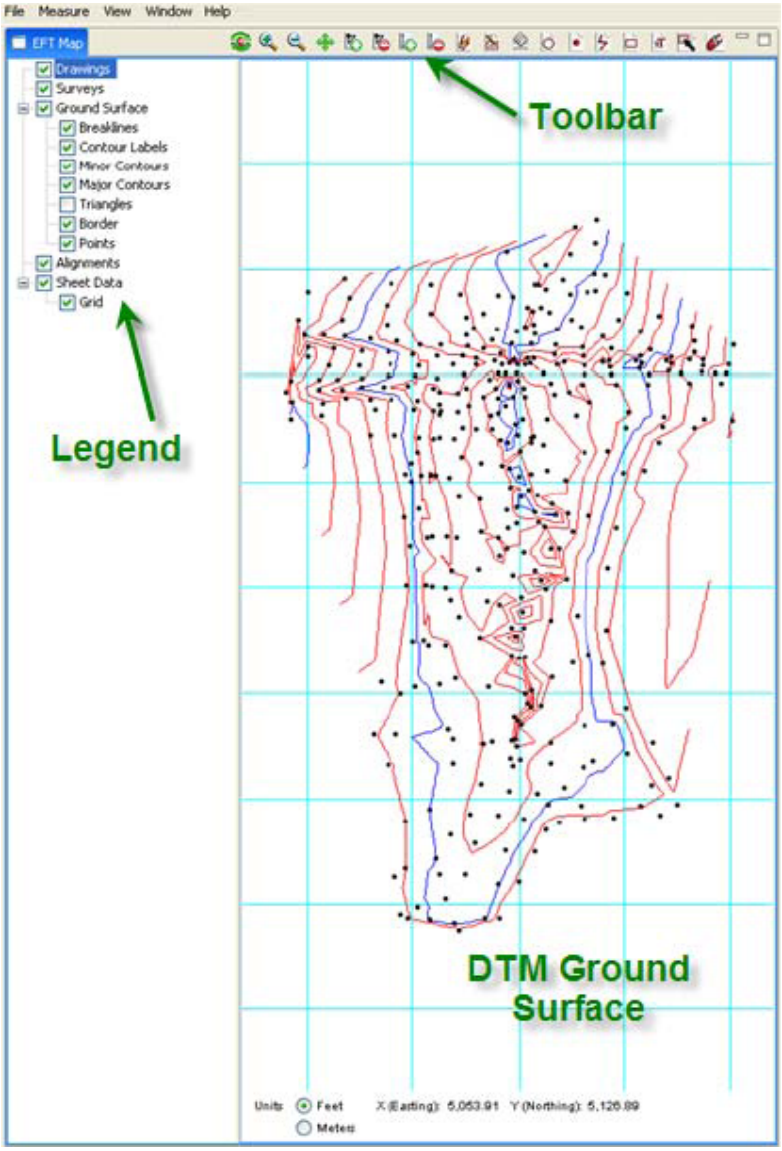
6. Opening Screen

When a new Waterway Manager is started, the following opening screen is displayed. The left window is the EFT Map window, and the right window is the Waterway Manager window.



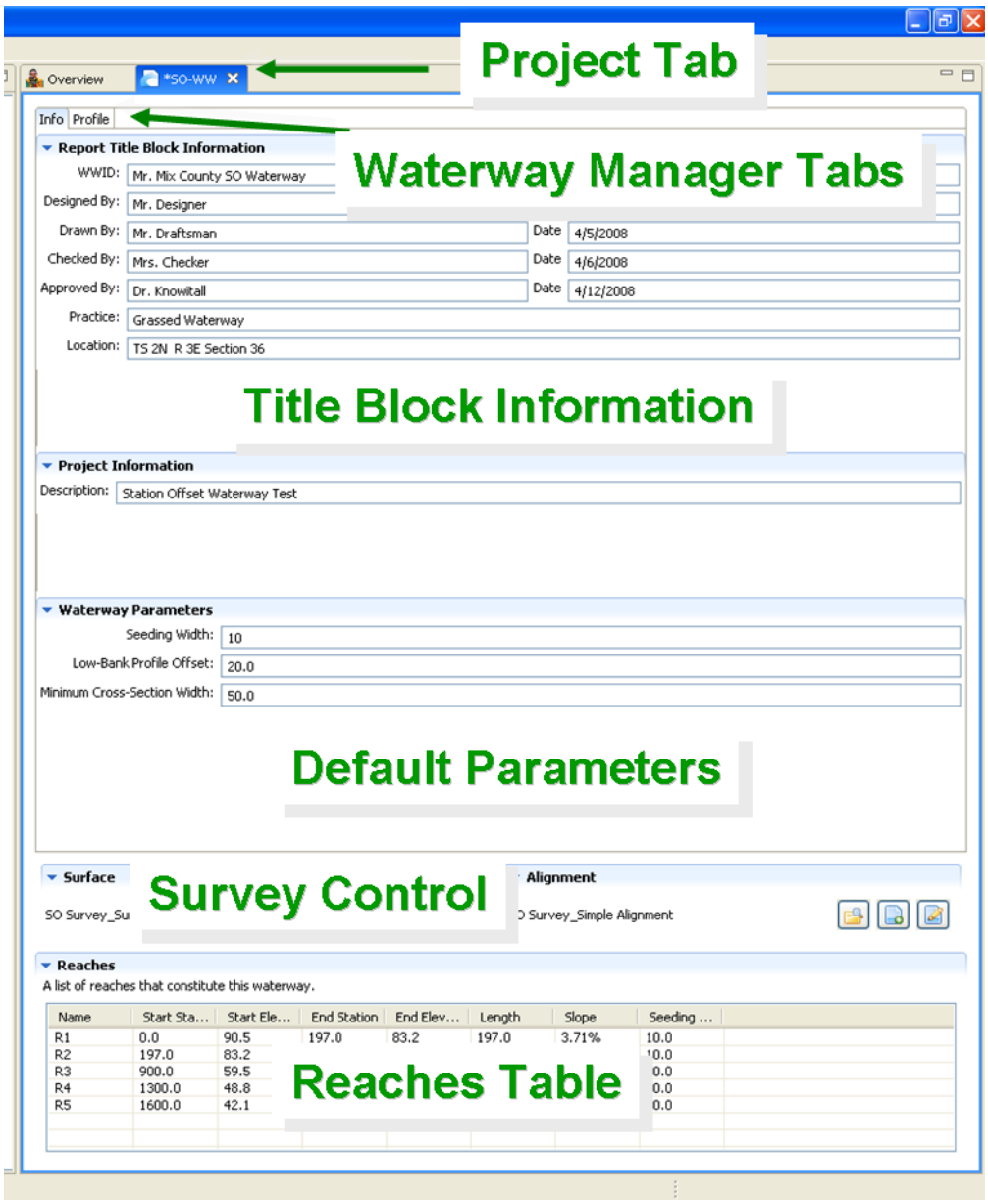
6.1. EFT Map Window

Below is a sample of a DTM displayed on the Map window. Note the Legend on the left and the Toolbar along the top. The Legend allows you to turn on and off different map features to be displayed. The Toolbar allows you to change the view, modify the DTM, perform measurements, and add drawing objects to the map.



6.2. Waterway Manager Window

Below is an example of what is presented in the Waterway Manager window. The tabs at the top level are the Overview tab, which gives you access to the customer and project management functions, and the currently opened Waterway Manager project.



6.2.1. Title Block Information

The title block information will be displayed in the title block of the output pages. WWID is essentially the project title. There is a limit to the number of characters available due to the limited space available in the title block. The Description in the Project Information block does not appear in any report output and is intended for you to add whatever notes may be needed. An example would be to keep track of multiple alternatives.

6.2.2. Seeding Width

The Waterway Default Parameters box contains the default seeding width, the low bank profile offset, and the Minimum Cross-Section Width. Seeding Width is the width of seeding that will be done on either side of the typical cross section. For a diversion, thee seeding width is added to the diversion width which is the width from uphill cross-slope/water intersect, to downhill berm-slope/cross-slope intersect. When the seeding width is set to zero, the seeding width will be the design top width of the cross section or the diversion width for diversions.

6.2.3. Low-Bank Profile Offset

When plotting the centerline profile, the program also plots a ground-elevation profile parallel to the centerline profile. This profile is the Low-Bank Profile. The Low-Bank Profile Offset is the distance from the centerline that ground elevation is determined. The program determines whether the left or right offset ground profile is lower and plots the lower of the two elevations for each point along the profile.

6.2.4. Minimum Cross Section Width

When plotting cross sections of the waterway, the program uses the Minimum Cross-Section Width to determine the minimum cross section plot width. If the design cross section is wider than the minimum, the program will widen the cross section plot width to accommodate the wider cross section.

7. Simple Case Reach (No Survey)

WDT has an option to create a simple case reach. This is a reach with no input of survey data. All that is needed is a reach name and slope and information on the reach channel properties, soils, and vegetation. The steps to creation of a simple case reach are as follows:

1. Add a reach to the reaches table.

2. Define the reach name and either the reach slope or the starting and ending stations and elevations.

3. Edit the reach.

4. Define the Channel Properties — click on the **Channel Properties** tab.

5. Define the Soils Parameters — click on the **Soils Parameters** tab.

6. Define the Vegetal Parameters — click on the **Vegetal Parameters** tab.

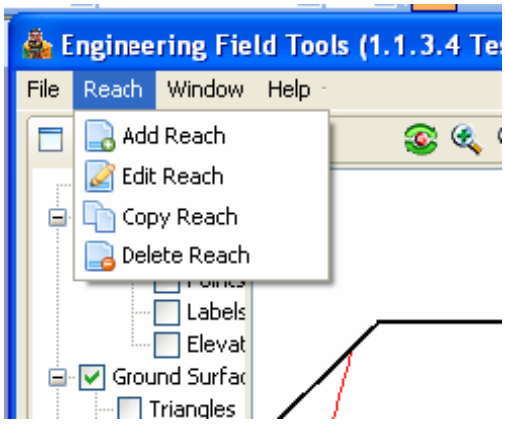
7. View the results.

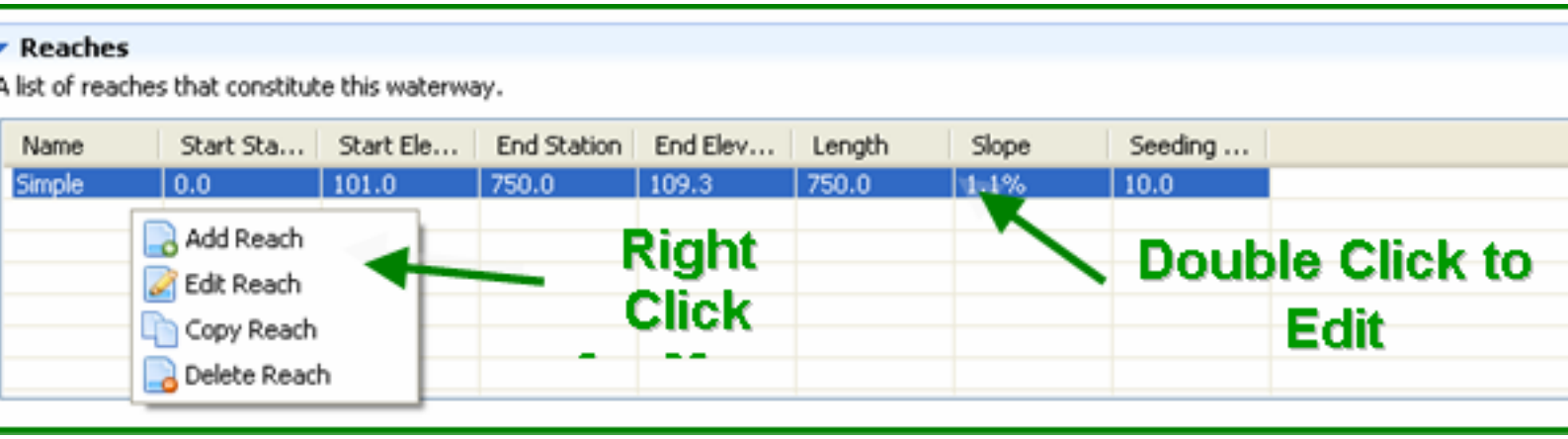
8. Reaches Table

The reaches table contains information on each reach of the waterway. Reaches are individual sections of a waterway or diversion. WDT calculates waterway design for each reach. There are a couple of different ways to add a waterway reach, using the simplified approach of using the **Add Reach** tool and the **Sketch Reach** tool once a survey has been entered. The Sketch Reach tool is discussed following the survey section of the help.

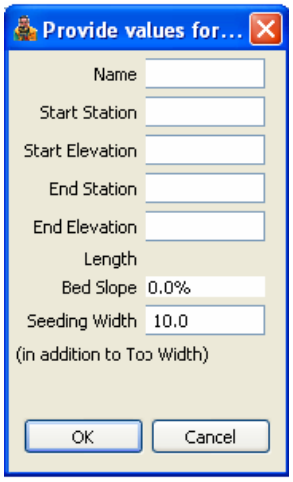
8.1. Add Reach

Reaches are added to the waterway reaches table in one of three ways: using the **Sketch Reach** tool within the profile window, using the drop-down reach menu on the main menu line, or by right clicking on the Reaches Table.





Upon clicking **Add Reach** on either of the drop-down menus, a pop-up box will prompt you to enter a name for the reach, the starting and ending stations and elevations and the seeding width. Once entered, a sketch of the profile will be displayed in the profile window. Note that it is NOT necessary to have a natural ground centerline or overbank profile to have a waterway reach.



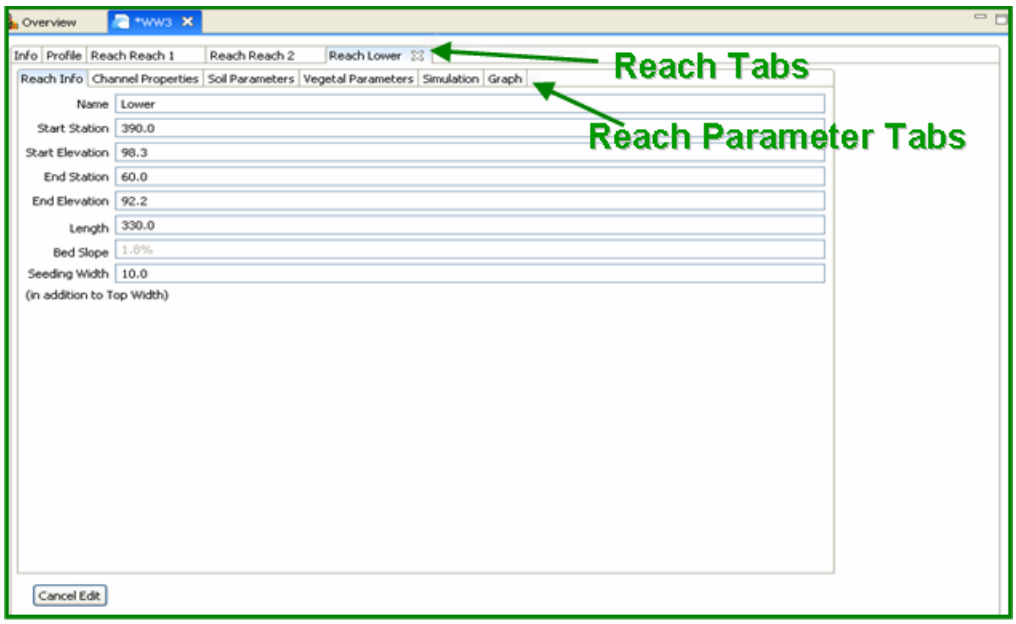
When entering the **Starting Station**, **Starting Elevation**, **Ending Station**, **Ending Elevation**, and **Slope**, the software will automatically calculate the fifth variable once four variables have been entered. For example, you can enter a starting and ending station, a starting elevation, and the slope, then the software will calculate the ending elevation. At a minimum, the software needs to have a slope value, entered or calculated, to calculate the dimensions of the waterway. If starting and ending stations and elevations are not entered, the software will be able to size the waterway if all other needed parameters are entered; however, the typical cross section report will be missing the stations and elevations.

8.2. Edit Reach

Editing the parameters of each reach can be accomplished by either choosing the **Edit Reach** option in the drop-down menu or by double clicking on the reach to be edited. Upon editing a reach, a new tab window is opened with the name of the reach. There will be several sub-tabs under this tab which allow you to enter information for each reach necessary to design the reach.

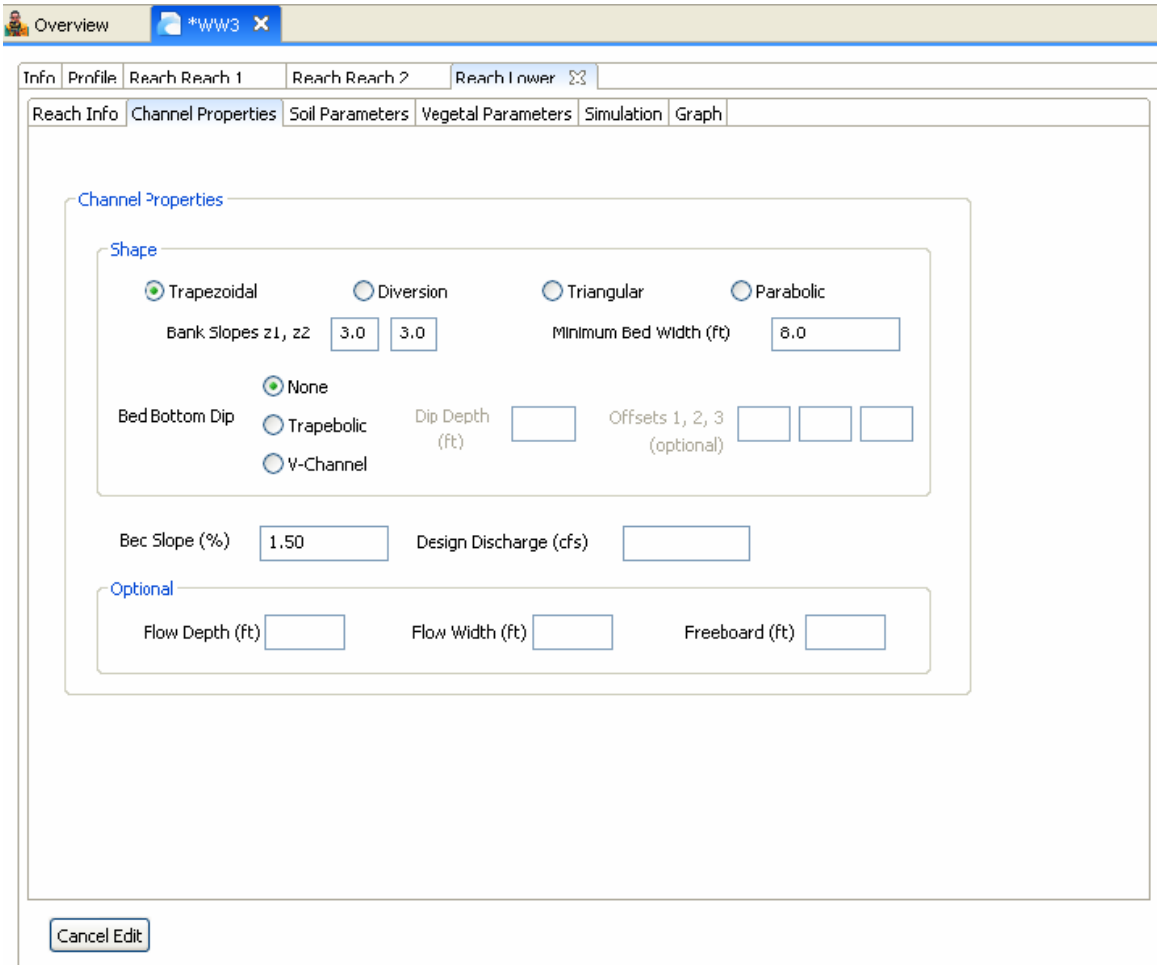
9. Reach Info

The Reach Info tab contains the same information as was contained in the pop-up box. You can edit this data as needed. The Bed Slope and Length inputs are grayed out and not editable if starting and ending stations and elevations have been entered.



9.1. Channel Properties

The Channel Properties define the physical shape and dimensions of the channel as well as the design discharge this channel needs to be designed for. Channel properties are defined by clicking on the *Channel Properties* tab. Each channel shape has different parameters which must be entered. When the entry cells have a white background, then input for that cell is expected.

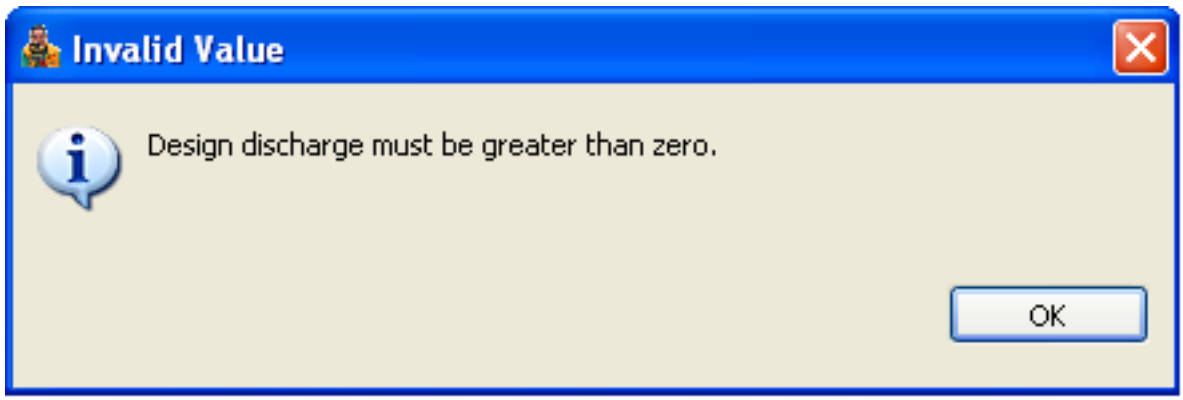


9.1.1. Bed Slope (%)

Bed slope is the slope of the channel bed expressed in percent in the direction of flow. Computations carried out by this routine assume steady uniform flow, implying that the bed, water surface, and hydraulic grade lines are parallel.

9.1.2. Design Discharge (cfs)

The Design Discharge in cubic feet per second is the discharge used in determining flow conditions in the channel. An error box will appear if the design discharge is not entered.



9.1.3. Optional Parameters

9.1.3.1. Fixed Width

This allows you to have the top width of the waterway fixed. The software will determine the best possible solution given the fixed width. You can have either a fixed width or a fixed depth, but not both at the same time. In some instances, the entered fixed width will be too small for a solution. WDT will display an error in this case which will typically be that the effective stress exceeds the allowable stress.

9.1.3.2. Fixed Depth

This allows you to have the depth of the waterway fixed. The software will determine the best possible solution given the fixed depth.

You can have either a fixed width or a fixed depth, but not both at the same time. In some instances, the entered fixed depth will be too small for a solution. WDT will display an error in this case which will typically be that the effective stress exceeds the allowable stress.

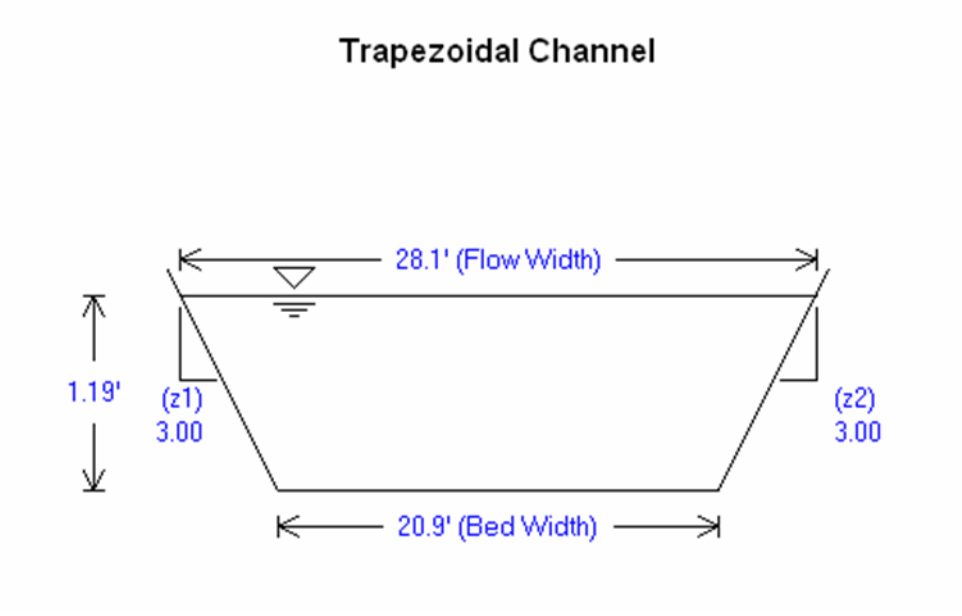
9.1.3.3. Freeboard

This allows you to enter a freeboard depth for the waterway which will be added to the calculated required depth.

9.1.4. Shape

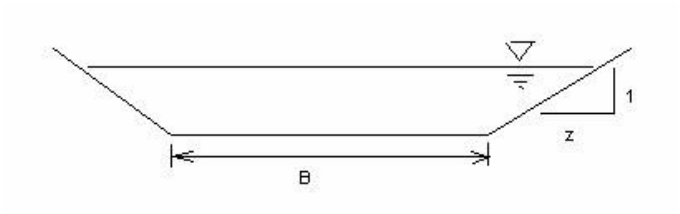
There are four options for channel shape, *Trapezoidal*, *Diversion*, *Triangular*, and *Parabolic*. You should not have more than 5 reaches with the same shape since this is the limit of the print capability of the program. If more reaches are needed, break the waterway into multiple waterways at some logical point and create another waterway manager within the same project. Multiple waterways within the same project can still be printed together.

9.1.5. Trapezoidal Shape



9.1.5.1. Minimum Bed Width (ft)

This is a required entry for all trapezoidal channels. The minimum bed width is the minimum value of the channel bed width that will be used in an attempt to set the computed erosionally effective stress equal to the allowable stress. Computed erosionally effective stress and total vegetal stress increase with decreasing bed width. If the computed stresses are less than the allowable stresses with the bed width equal to the entered Minimum Bed Width, the bed width is set to the entered value, and a message is issued indicating that stability did not govern the cross section dimensions.



9.1.5.2. Bank Slopes (z1, z2)

This is a required entry for all trapezoidal channels. The bank side slopes are entered as the ratio of additional cross section width per foot of depth for each bank. The cotangent, z, of the bank slope of a trapezoidal or triangular channel.

9.1.5.3. Bed Slope (ft/ft)

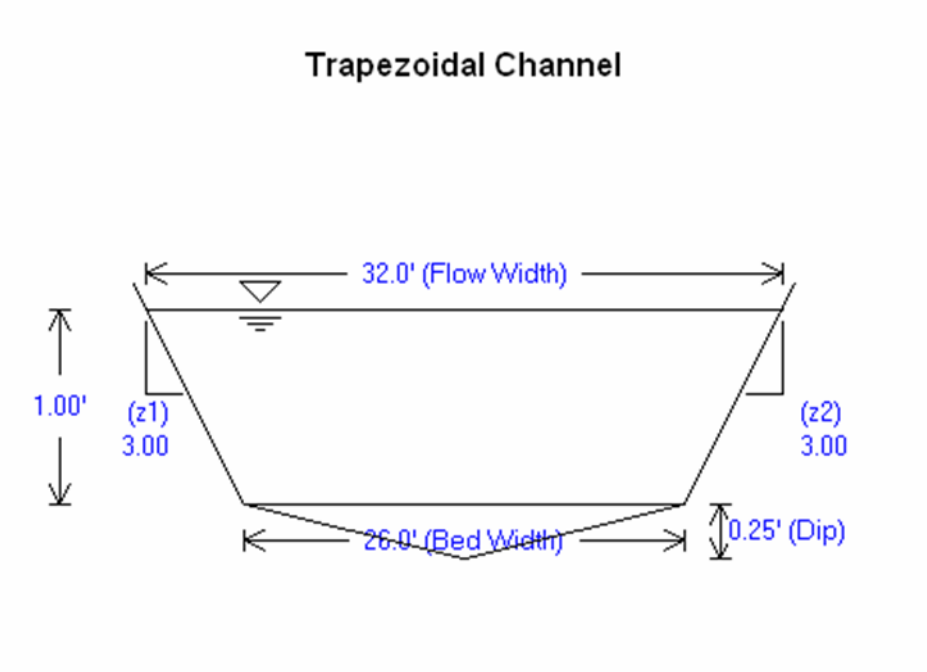
Bed slope is the slope of the channel bed expressed in percent of fall of the channel length in the direction of flow. Computations carried out by this routine assume steady uniform flow implying that the bed, water surface, and hydraulic grade lines are parallel.

9.1.5.4. Design Discharge (cfs)

The Design Discharge in cubic feet per second is the discharge used in determining flow conditions in the channel.

9.1.5.5. Bed Bottom Dip

You have three options for Bed Bottom Dip, None, Trapobolic, and V-Channel. None is the default entry and has no modification for a dip in the bottom of the trapezoidal section.



The V-Channel adds a triangular shape dip to the trapezoidal bottom. The depth of the triangular dip must be entered.

The Trapebolic option adds a parabolic dip to the trapezoidal bottom. The depth of the parabolic dip must be entered and you can enter optional offset distances for determination of depth in order to aid in stake out.

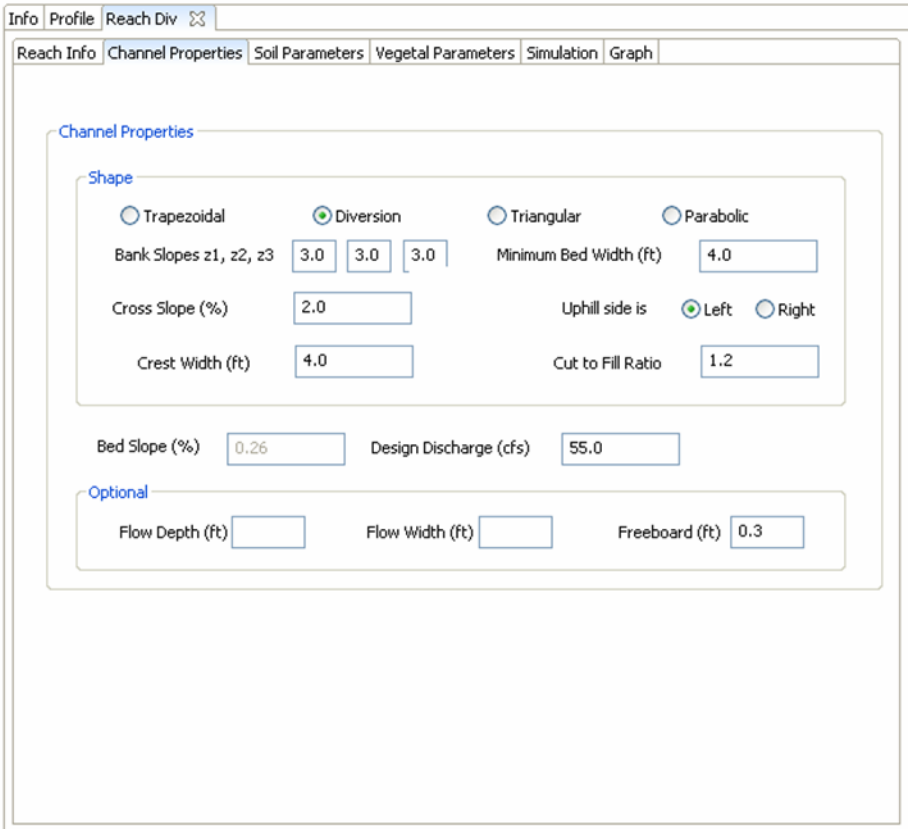
9.1.6. Diversion

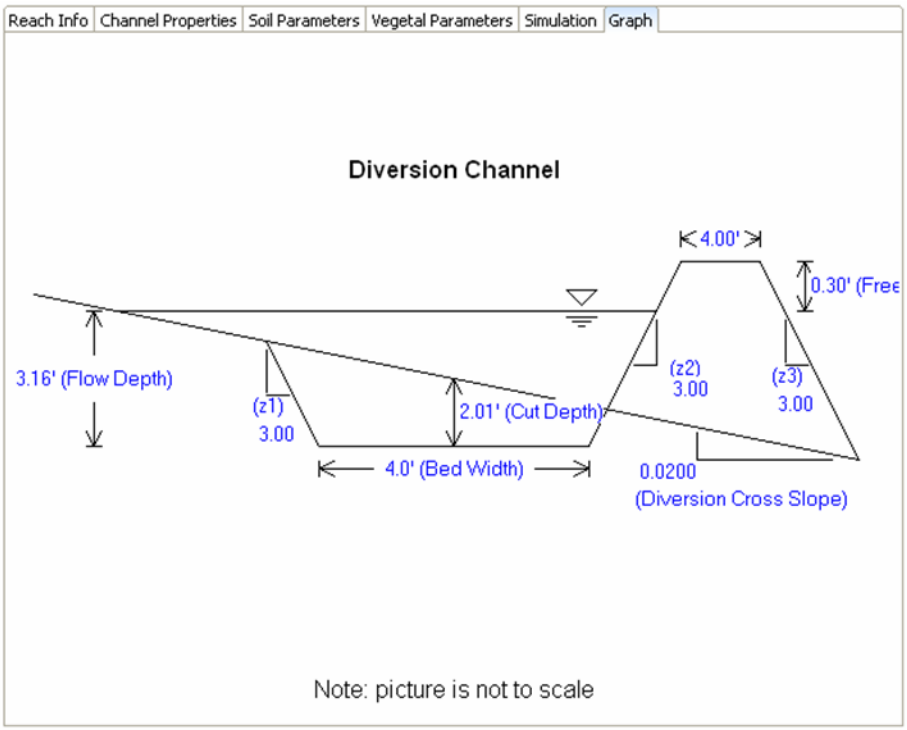
Diversions are very similar to waterways since both can be vegetated or earthen lined channels established to carry surface water at a non-erosive velocity to a stable outlet. Since the design procedure for a diversion is basically

the same as for a waterway, a diversion option has been included in the Waterway Design Tool. The diversion option does have some added capability to optimize the size of the diversion to match a user defined cut to fill ratio. This cut to fill ratio optimization only accounts for a two dimensional balancing of cut to fill for the typical diversion cross section.

Additionally, the calculations for stability and capacity for a diversion are slightly different. Stability calculations only account for flow within the trapezoidal section of the diversion. Capacity calculations do account for the flow within the overflow area. For stability calculations, the overflow area will have lower velocity and thus it was determined that not including the overflow area should be conservative. The capacity calculations for the overflow area do assume that the soil and vegetative parameters for the overflow area are the same as for the main trapezoidal cross section of the diversion.

WDT assumes the alignment runs through the center of the cross section template except in the case of a diversion. For a diversion, the alignment runs through the center of the trapezoidal cross section part of the diversion cross section.





9.1.6.1. Bank Slopes (z1, z2, z3)

The bank side slopes are entered as the ratio of additional cross section width per foot of depth for each bank. The cotangent, z, of the bank slope of a trapezoidal or triangular channel.

9.1.6.2. Minimum Bed Width (ft)

The minimum bed width is the minimum value of the channel bed width that will be used in an attempt to set the computed erosionally effective stress equal to the allowable stress. Computed erosionally effective stress and total vegetal stress increase with decreasing bed width. If the computed stresses are less than the allowable stresses with the bed width equal to the entered Minimum Bed Width, the bed width is set to the entered value, and a message is issued indicating that stability did not govern the cross section dimensions.

9.1.6.3. Cross Slope (%)

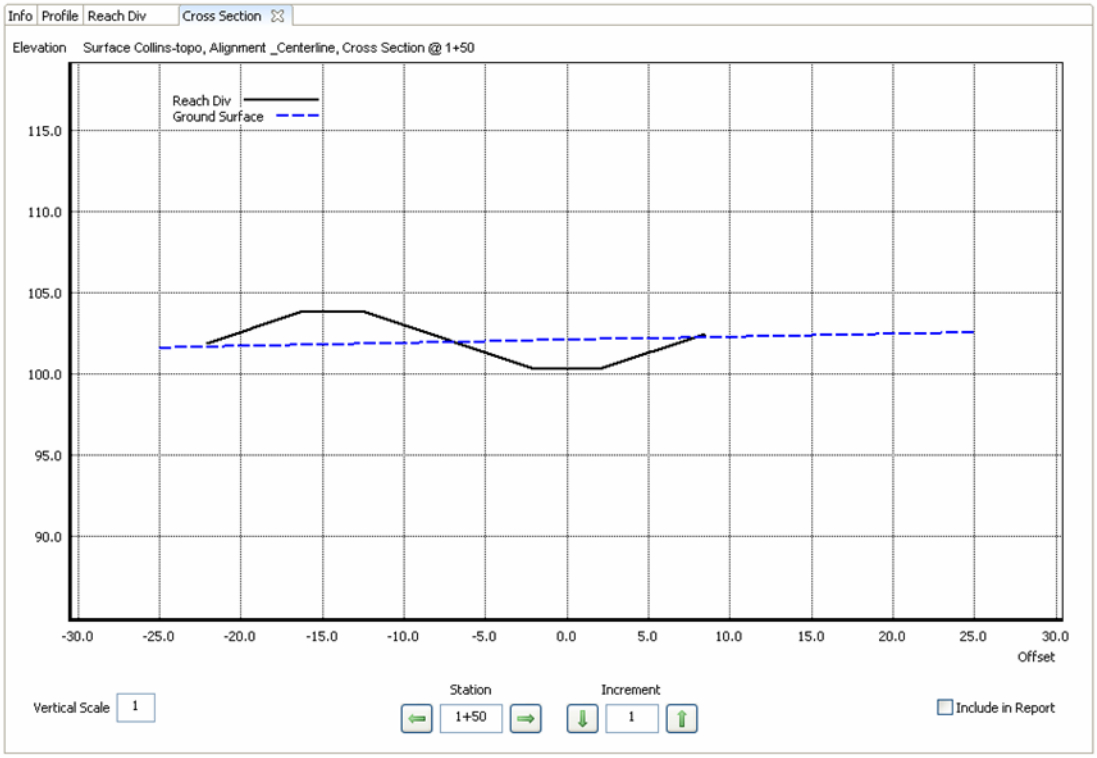
Cross slope is shown as diversion cross slope in the Diversion Channel graphic above. Cross slope is defined as the land slope perpendicular to the direction of the diversion. This slope is used in the calculation of cut and fill.

9.1.6.4. Crest Width

The top width of the diversion.

9.1.6.5. Uphill Side

You are prompted to choose whether the uphill side of the diversion is left or right. This left or right is used to place the diversion template on the cross section. Since the template for a diversion is not symmetrical and the slope on a cross section graph can be from left to right or visa versa, the software needs to know how you want the template displayed. The example below shows the uphill side to the right.



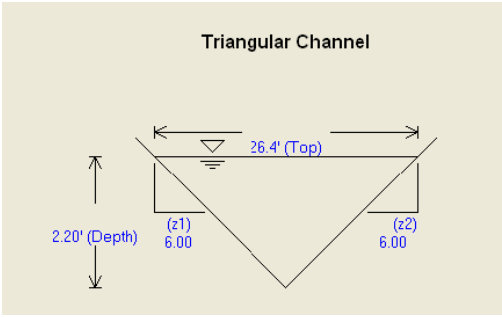
9.1.6.6. Cut to Fill Ratio

This is the desired ratio of cut volume to fill volume. The program uses this ratio to calculate optimum channel width and depth.

9.1.6.7. Freeboard

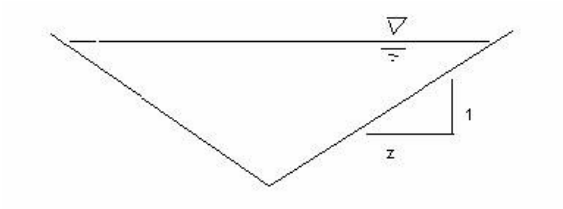
Minimum distance from the top of the diversion to the design water surface elevation. The minimum freeboard for a diversion is 0.3 feet.

9.1.7. Triangular Shape

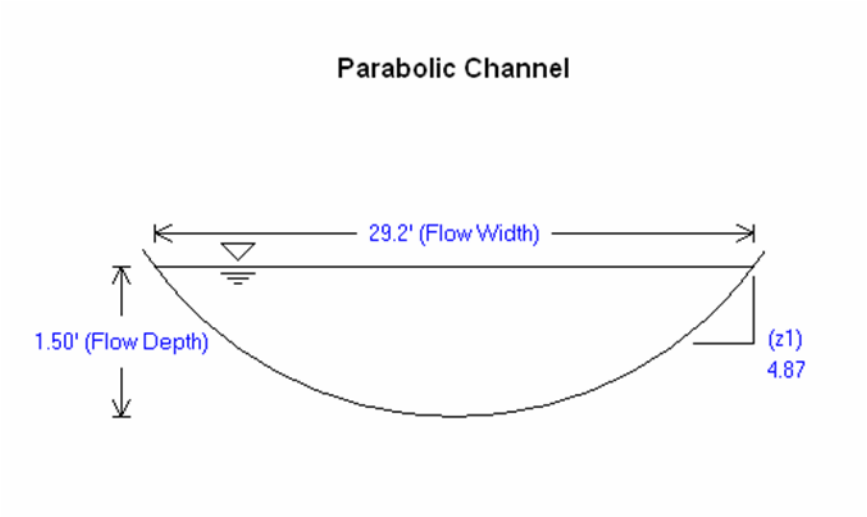


9.1.7.1. Limiting Bank Slopes (z1, z2)

The limiting bank slope is the minimum value of bank slope, z, that will be used in an attempt to set the computed erosionally effective stress equal to the allowable stress. Computed erosionally effective stress and total vegetal stress increase with decreasing z (steeper slope). If the computed stresses are less than the allowable stresses with the bank slope equal to the entered cotangent steepest allowable bank slope, the bank slope is set to the entered value, and a message is issued indicating that stability did not govern the cross section dimensions.



9.1.8. Parabolic Shape

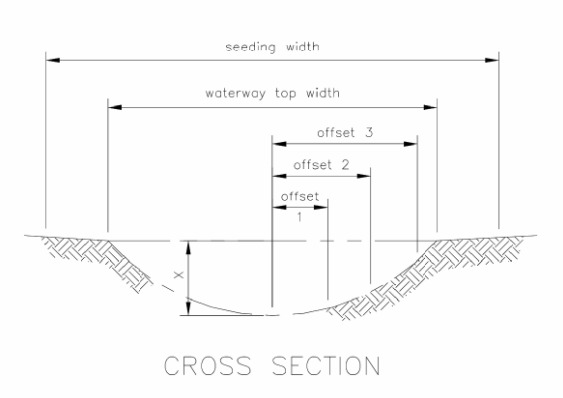


9.1.8.1. Limiting Bank Slopes (z1)

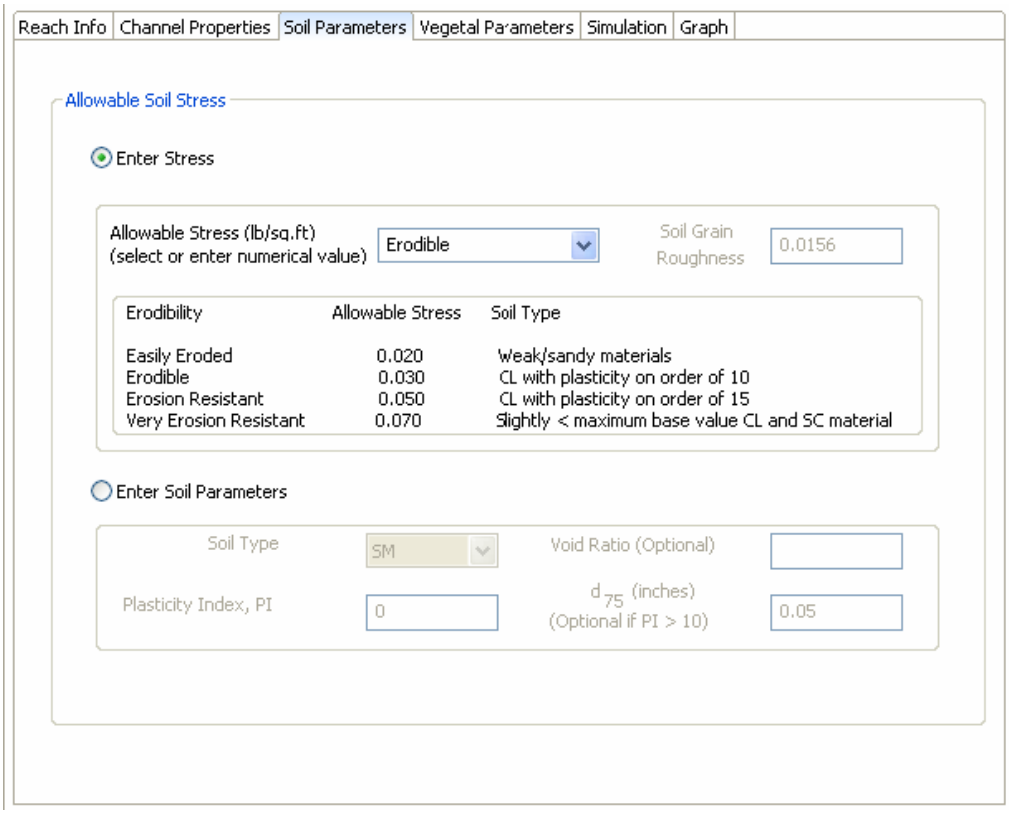
The limiting bank slope is the minimum value of bank slope, z, that will be used in an attempt to set the computed erosionally effective stress equal to the allowable stress. For the parabolic shape, the bank slope is at the water surface, and bank slope at water surface for the capacity computations may govern the channel cross-section coefficient. An example limiting bank slope might be 3:1 where any bank slope steeper than 3:1 would cause problems for on farm equipment crossing the waterway. Computed erosionally effective stress and total vegetal stress increase with decreasing z (steeper slope). If the computed stresses are less than the allowable stresses with the bank slope equal to the entered cotangent steepest allowable bank slope, the bank slope is set to the entered value, and a message is issued indicating that stability did not govern the cross section dimensions. Since the program uses an iterative process to determine the final answer, final bank slope may be slightly greater than the entered limiting bank slope. If this causes a problem, then increase the value entered for the minimum bank slope.

9.1.8.2. Offsets (optional)

You can enter up to 3 offset distances for the software to calculate depth. Offset distances and depths will aid in the stake-out process.



9.2. Soil Parameters Tab



The allowable stress in pounds per square foot is the allowable hydraulic stress on the soil. This software calculates the channel width (bed width, side slope, or parabolic channel coefficient) required to force the computed erosionally effective stress to be equal to or less than the allowable stress.

This section allows you the choice of two different methods of entry: entry of stress directly or entry of soil parameters which will be used to calculate the allowable stress.

9.2.1. Enter Stress

You can choose from a drop-down menu of Allowable Stress with options shown in the table below.

Erodability	Allowable Stress	Corresponding Soil Type
Easily Eroded	0.02 lb/ft2	weak/sandy materials
Erodible	0.03 lb/ft2	CL with plasticity on order of 10
Erosion Resistant	0.05 lb/ft2	CL with plasticity on order of 15
Very Erosion Resistant	0.07 lb/ft2	slightly < maximum base value CL and SC material

You can also choose to enter the Allowable Stress directly as a number by entering a number value directly in the drop-down box. If this option is chosen, you must also enter a soil grain roughness.

9.2.2. Soil Grain Roughness

Soil grain roughness is the hydraulic roughness associated with the particles or aggregates that may be detached by hydraulic stresses on the order of the Allowable Stress. Soil Grain Roughness is expressed in terms of a Manning coefficient as a function of representative particle size. For materials where the flow detaches discrete particles, the representative particle size is taken as that for which 75% of the material is finer by weight (d75), and the relation of particle size to Soil Grain Roughness is as shown in USDA, Ag. Handbook #667.

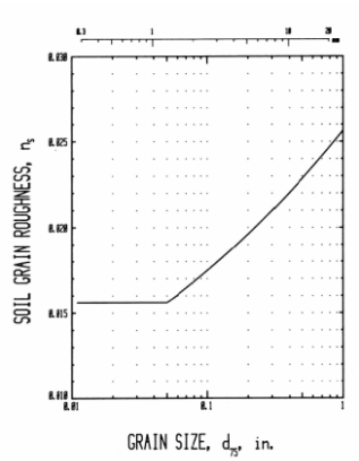


Figure 3.2
Soil grain roughness for noncohesive soils.

9.2.3. Enter Soil Parameters

9.2.3.1. Soil Type

The Soil Type is the soil's classification by the Universal Soil Classification System and is used in computation of the allowable stress for the soil. You will select from a drop-down list.

9.2.3.2. Plasticity Index

The plasticity index is the plasticity index for the soil material on the channel boundary. The plasticity index is used in computing the Allowable Stress for soil materials having plasticity index values greater than 10 as shown below (USDA, Ag. Handbook #667). Soils with plasticity index values less than 10 are assumed to erode as non-cohesive materials and Allowable Stress is determined from representative particle diameter.

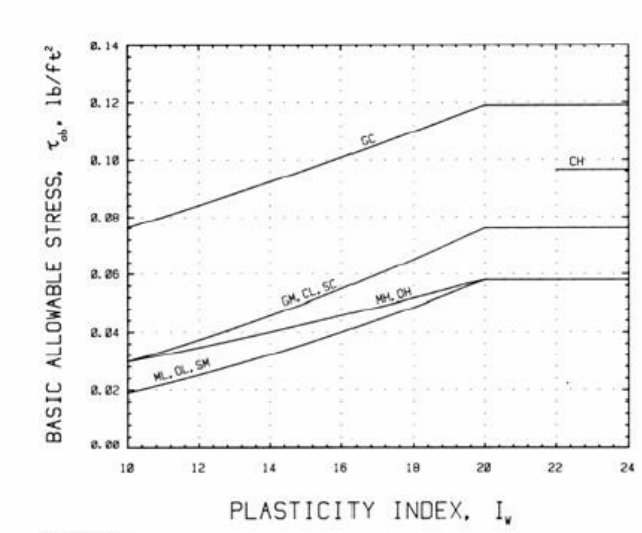


Figure 3.3
Basic allowable effective stress for cohesive soils (compiled from SCS (1977) Permissible Velocities).

9.2.3.3. Void Ratio

Optional Entry. The void ratio is the void ratio of the soil material on the channel boundary. It is used in computing the allowable stress for cohesive soils having plasticity index values greater than 10. For these soils, the basic allowable stress based on soil plasticity index is modified by the square of the void ratio correction factor determined as shown below (USDA, Ag. Handbook #667). If no void ratio is entered, a correction of 1.0 is assumed.

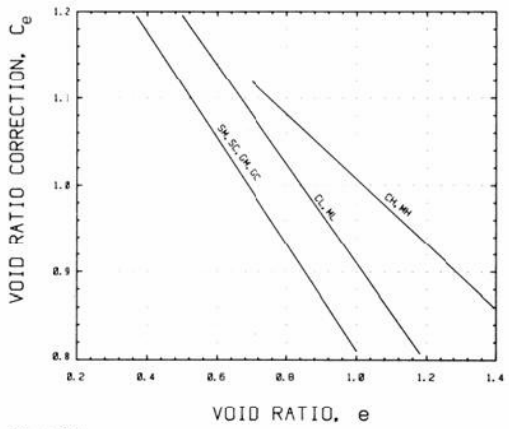


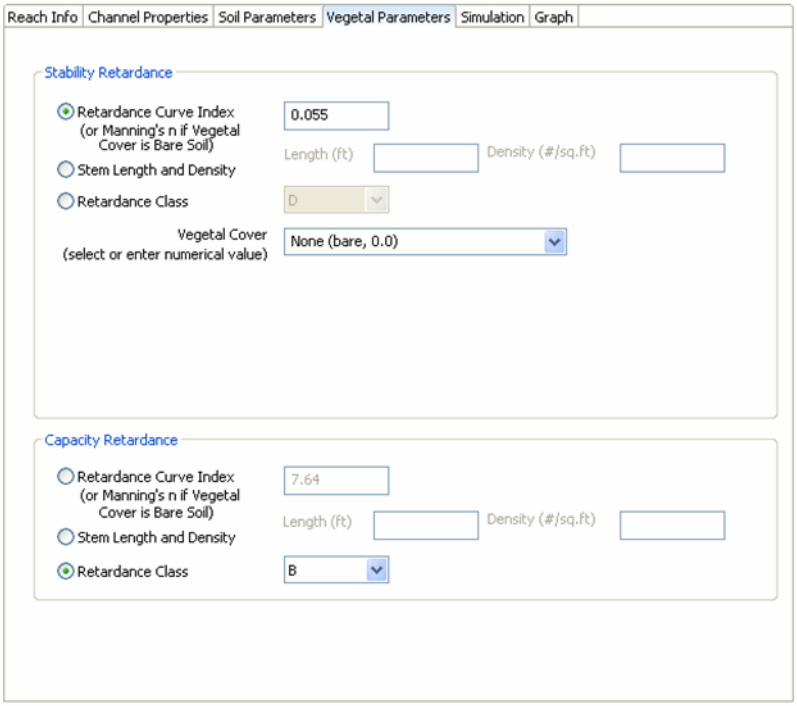
Figure 3.4
Void ratio correction factor for cohesive soils (after SCS (1977)).

9.2.3.4. d75

The Diameter is the representative particle size in inches of the soil on the channel boundary. The representative diameter for materials that erode as discrete particles is taken to be the particle diameter for which 75%, by weight, of the material is finer. This value is used in computation of the Allowable Stress for non-cohesive materials and of the Soil Grain Roughness. All materials having a plasticity index less than 10 are assumed to be non-cohesive for purposes of computing Allowable Stress. The relation of diameter to allowable stress for these materials is given by USDA, Ag. Handbook #667.

9.3. Vegetal Parameters Tab

Design of grass-lined channels follows the general procedure outlined in USDA, Ag. Handbook No. 667. The design is carried out in two parts, stability and capacity to account for the fact that vegetal conditions may vary through the growing season. The properties of the cross section (minimum channel width) are established such that the applied erosionally effective stress is equal to the allowable value for minimum anticipated cover (stability), and the flow depth required to convey the design discharge (capacity) is established using the maximum anticipated flow resistance (greatest vegetal cover length and density). For the vegetal parameters section, you will enter data for both the stability design and for the capacity design.



9.3.1. Stability Design

The properties of the cross section (minimum channel width) are established such that the applied erosionally effective stress is equal to the allowable value for minimum anticipated cover.

9.3.2. Channel Capacity Design

Channel capacity computations are an iterative solution of the equations describing the interaction of the flow with the vegetal cover for the purpose of determining the channel discharge, given the normal flow depth in a specified channel. The properties of the cross section (minimum channel width) are established such that the flow depth required to convey the design discharge (capacity) is established using the maximum anticipated flow resistance (greatest vegetal cover length and density).

9.3.3. Earth-Lined Channel

The Waterway Design Program can be used to design bare earth channels using the effective stress methodology. In order to design an earth-lined channel, enter the manning's n value for the earth lined channel in the box for the Retardance Curve Index in both the Stability Retardance and the Capacity Retardance sections. Additionally, enter None or 0.0 for the Vegetal Cover Index.

9.3.4. Retardance Curve Index

The retardance curve index is required for computation of flow resistance for the channel. If a value less than one is entered in this field, a non-vegetated, earth-lined condition is assumed, and the entry is assumed to correspond to a fixed value of Manning’s roughness coefficient. When a value greater than one is entered, the entered value is assumed to be retardance curve index and Manning’s coefficient is computed based on the interaction of the vegetation with the flow field as described in USDA, Ag. Handbook #667. For trapezoidal channels, Manning’s coefficient is adjusted slightly to account for the large difference in roughness between the bank and central areas of the channel. The primary variation of Manning’s coefficient with the product of velocity and hydraulic radius is represented by (Flow Retardance of Submerged Grass Channel Linings, Trans. ASAE, 25(5):1300-1303).

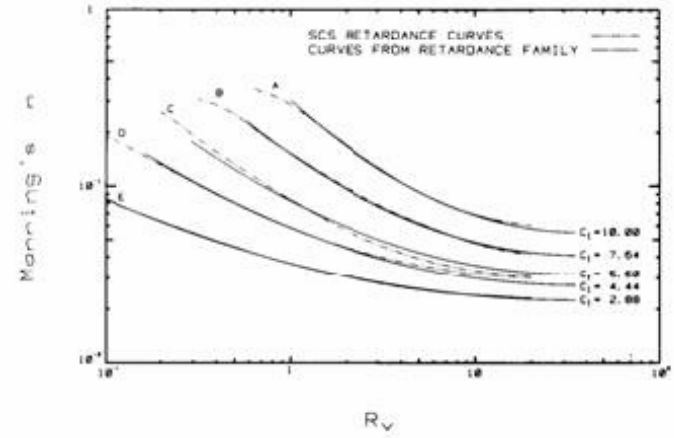


FIG. 1 Comparison of specified members of the retardance curve family with the USDA, SCS (1954) retardance curves.

9.3.5. Stem Length (ft)

The Stem Length is the representative length of the stems in feet. The representative length is best represented as the root mean square of the length of the individual stems. This parameter is used in computation of the Retardance Curve Index from the relation:

$$C_I = 2.5(h\sqrt{M})^{1/3}$$

where h is the stem length in feet M is the stem density in stems per square foot.

9.3.6. Stem Density (#/sq ft)

The stem density is the average stem density over the wetted perimeter of the channel cross section in number of stems per square foot. Stem density is used in computing the Retardance Curve Index.

9.3.7. Retardance Class

The Retardance Class is an alternate representation of the flow retardance potential of the vegetation. The retardance class used is that established in SCS TP-61 and traditionally used in computation of vegetal flow resistance. The corresponding values of Retardance Curve Index for the various Retardance Classes are:

Retardance Class	Retardance Curve Index
A	10.0
B	7.64
C	5.60
D	4.44
E	2.88

9.3.8. Vegetal Cover Factor

Used for stability design and stable slope computations, the Vegetal Cover Factor describes the ability of the vegetal cover to protect the soil boundary from concentrated flow and from stress fluctuations associated with turbulent sweep-ejection processes. A Vegetal Cover Factor of zero, corresponding to a non-vegetated channel, is implied when Manning's n is entered in place of Retardance Curve Index. For relatively uniform covers, the Vegetal Cover Factor is dominated by cover growth characteristics and may be estimated from USDA, Ag. Handbook #667.

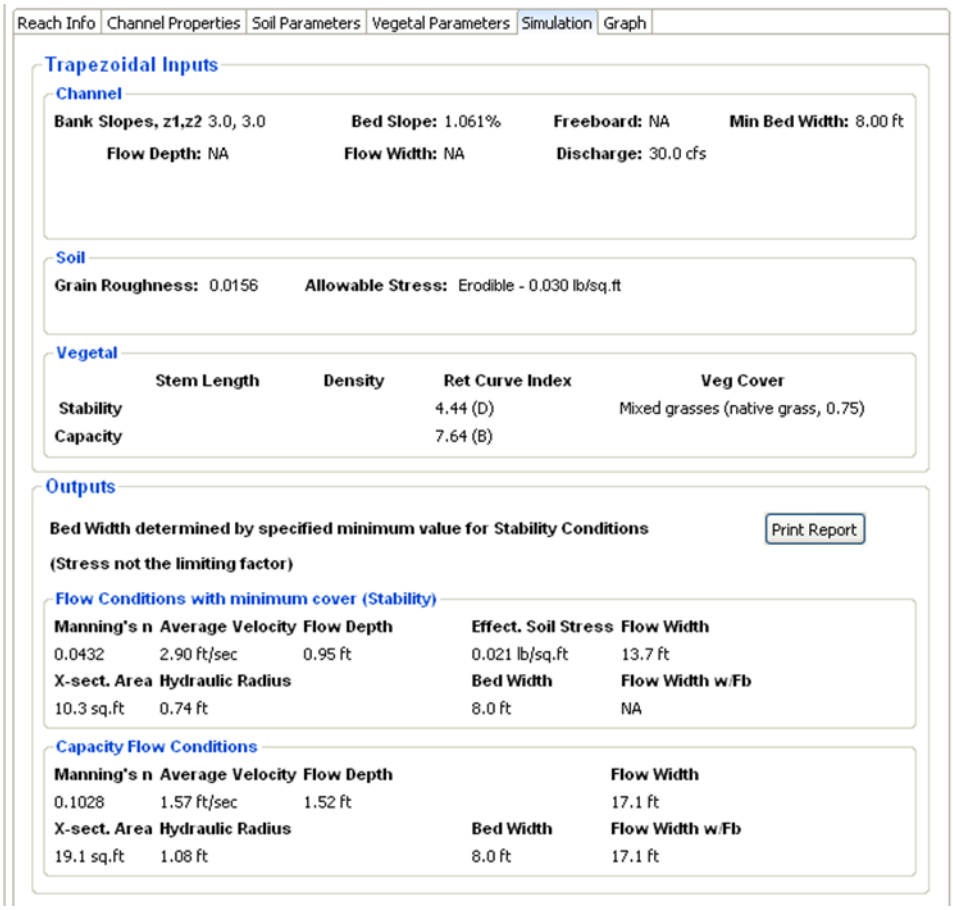
Table 3.1
Properties of grass channel linings: value apply to good uniform stands of each cover[1]

Cover factor C_F	Covers tested	Reference stem density (stem/ft^2)
0.90	bermudagrass	500
	centipedegrass	500
.87	buffalograss	400
	kentucky bluegrass	350
	blue grama	350
.75	grass mixture	200
.5	weeping lovegrass	350
	yellow bluestem	250
.5	alfalfa[2]	500
	lespedeza sericea[2]	300
.5	common lespedeza	150
	sudangrass	50

Multiply the stem densities given by l/3, 2/3,1, 4/3, and 5/3, for poor, fair, good, very good, and excellent covers, respectively. The equivalent adjustment to CF remains a matter of engineering judgment until more data are obtained or a more analytic model is developed. A reasonable, but arbitrary, approach is to reduce the cover factor by 20 percent for fair stands and 50 percent for poor stands. CF values for untested covers may be estimated by recognizing that the cover factor is dominated by density and uniformity of cover near the soil surface. Thus, the sod-forming grasses near the top of the table exhibit higher CF values than the bunch grasses and annuals near the bottom. For the legumes tested, the effective stem count for resistance (given) is approximately five times the actual stem count very close to the bed. Similar adjustment may be needed for other unusually large-stemmed, branching, and/ or woody vegetation.

You can choose from a drop-down list containing five cover types which are assumed to be in good condition: Bunch grasses (Love grass 0.5), Mixed grasses (native grass 0.75), Turf grasses (Buffalo grass 0.87), Creeping grasses (Bermudagrass 0.9), None (bare 0.0) or you can enter a numerical value of your own.

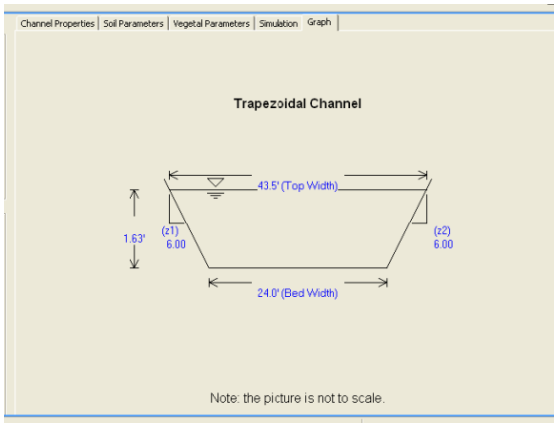
9.4. Simulation Tab



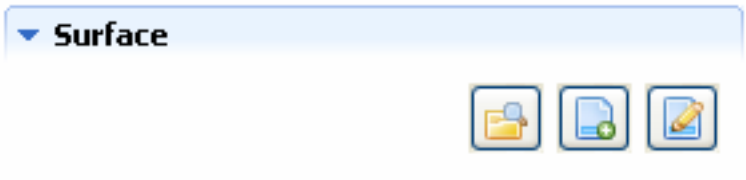
The simulation tab shows you inputs in the Inputs section and the resulting output in the Outputs section. The output will show whether stability or capacity design is the controlling factor in design.

9.5. Graph Tab

The graph tab shows the current design of the selected reach. The graphic is not to scale but does show the physical dimensions of the waterway. The graphic shows the actual flow width and depth and does not include freeboard.



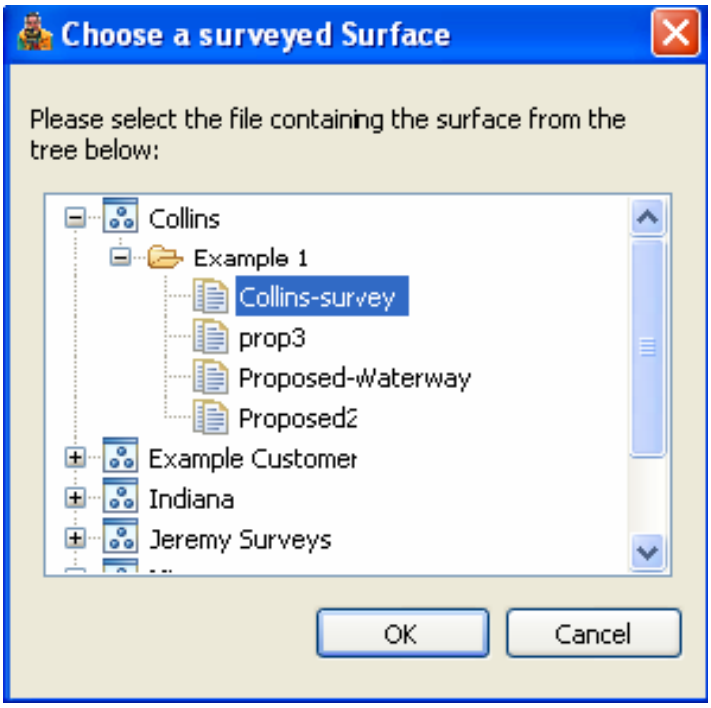
10. Surface Box (Survey)



As shown above, the surface box contains three options for utilizing survey information within WDT. WDT converts surveys to digital terrain model surfaces which is why this section is called surface and not survey.

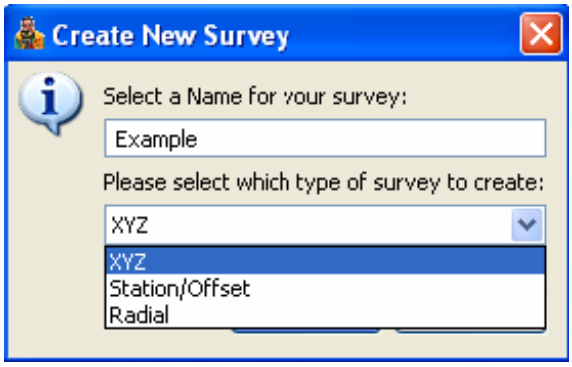
10.1. Select a Surface

Selecting this icon allows you to select from surveys that have already been entered within SET. Upon selecting this icon, a window will pop-up, which will allow the selection of an existing survey.



10.2. New Survey

You have the option of creating a new survey from within WDT. Selecting this icon will launch a new window which will require you to name the new survey and choose from a drop-down menu whether the survey is XYZ, Station/Offset, or Radial. Entering a new survey from within WDT is covered within the next section.



10.2.1. Survey Input

Survey data is entered in one of three formats, depending on how the survey is collected in the field:

1. XYZ format

   This type of survey has rectangular coordinates (X, Y, and Z or Northing, Easting, and Elevation). This type of data comes from total station survey instruments, GPS, and LIDAR. Grid style surveys can also be entered as an XYZ survey type. This survey data can be imported from an existing file or can be manually entered.

2. Station-Offset

   This survey is typically done by defining an alignment (a profile) and cross-sections perpendicular to the alignment. Stations are defined along the alignment, and offset shots define the cross-sections at user defined stations. Two kinds of alignments can be defined in SET: Simple Alignments and User Defined Alignments. Simple alignments need not be defined prior to entering cross-sections. Simple alignments are limited to straight lines pointing north and starting at station 0+00. User defined alignments allow all other possibilities, that include deflections and curves. Refer to the Station-Offset section below that describes alignments.

3. Radial

   This type of survey is collected using transits and theodolites. Points are defined by horizontal angle and distance, with an elevation. Various types of instrument moves are supported by SET when the survey requires more than one instrument point. This Radial input routine replaces the SSRP program within the Ohio suite of engineering programs.

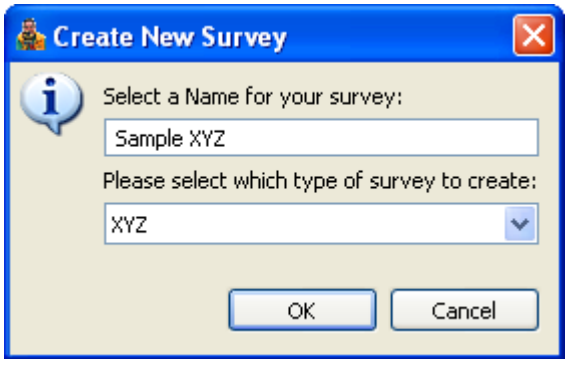
   #### Note

   The DTM will not be processed (contours will not be displayed) until the Survey Input Editor is closed.

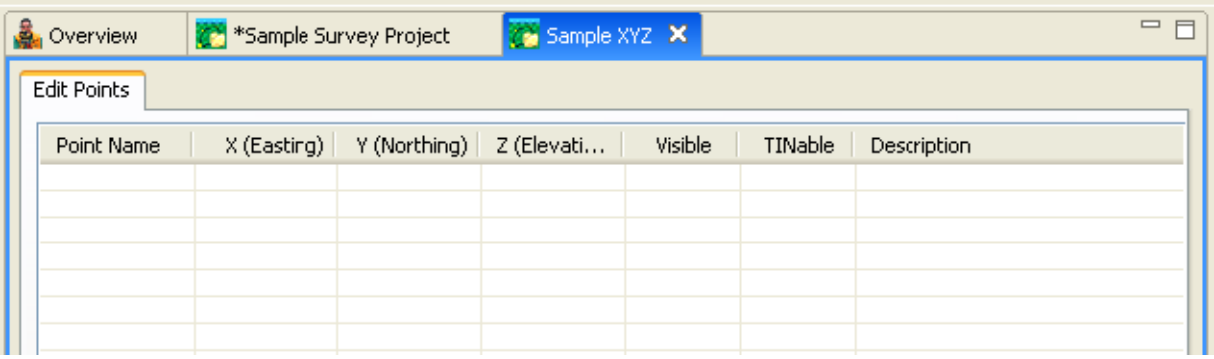
10.2.1.1. XYZ Survey Input

XYZ survey data can be manually entered or imported.

1. Enter the name of this XYZ survey in the pop-up window, and be sure XYZ is shown in the Survey type drop-down list. XYZ is the default selection. Click OK and the XYZ Input Editor will open.

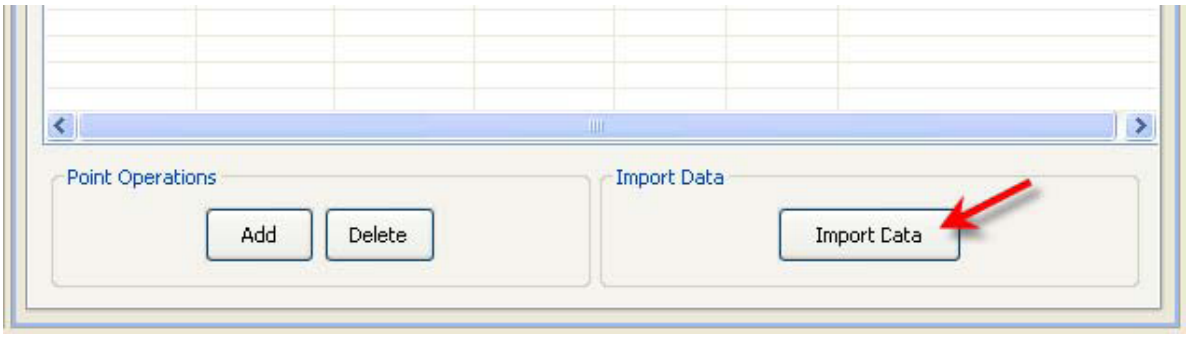


2. When a new XYZ survey is created, a blank Input Editor screen will display as shown below.

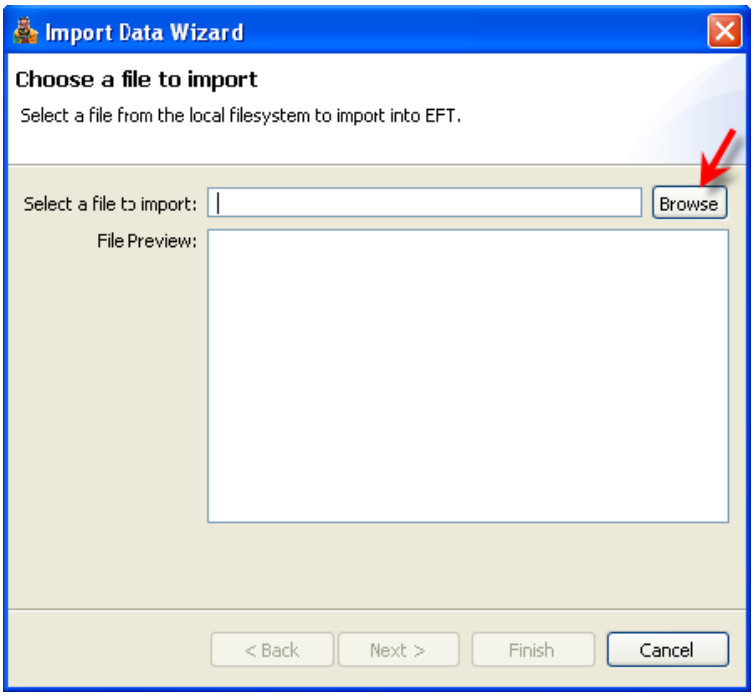


10.2.1.1.1. Importing XYZ Data

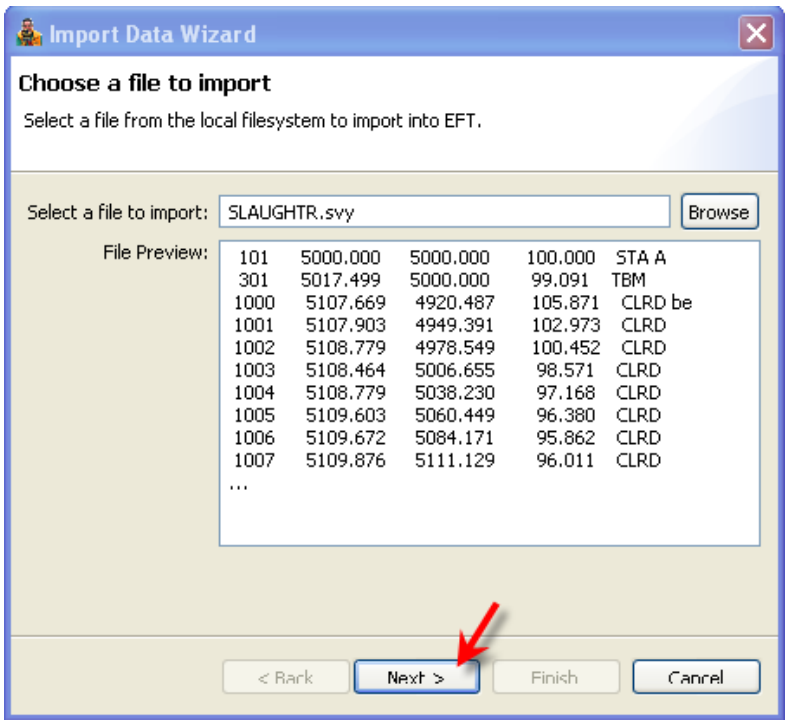
1. To import an existing XYZ data file into SET, press the IMPORT DATA button.



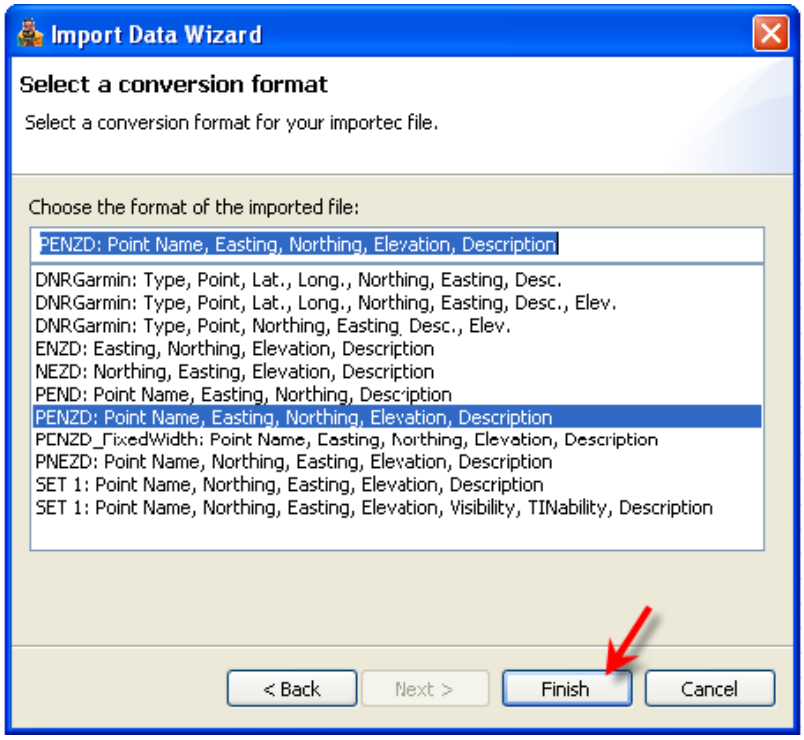
2. The Import Data Wizard screen will appear. Press the BROWSE button to navigate to the file containing your XYZ survey data.



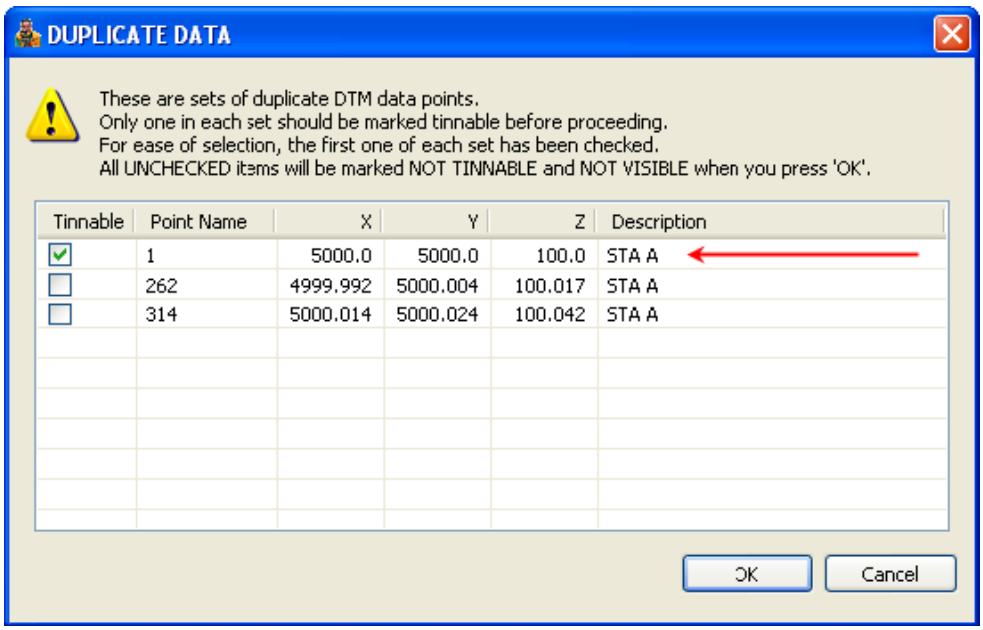
3. When the file is selected, the Import Wizard will display the file name, and preview some of the points to help determine the format of the data. Press the NEXT button.



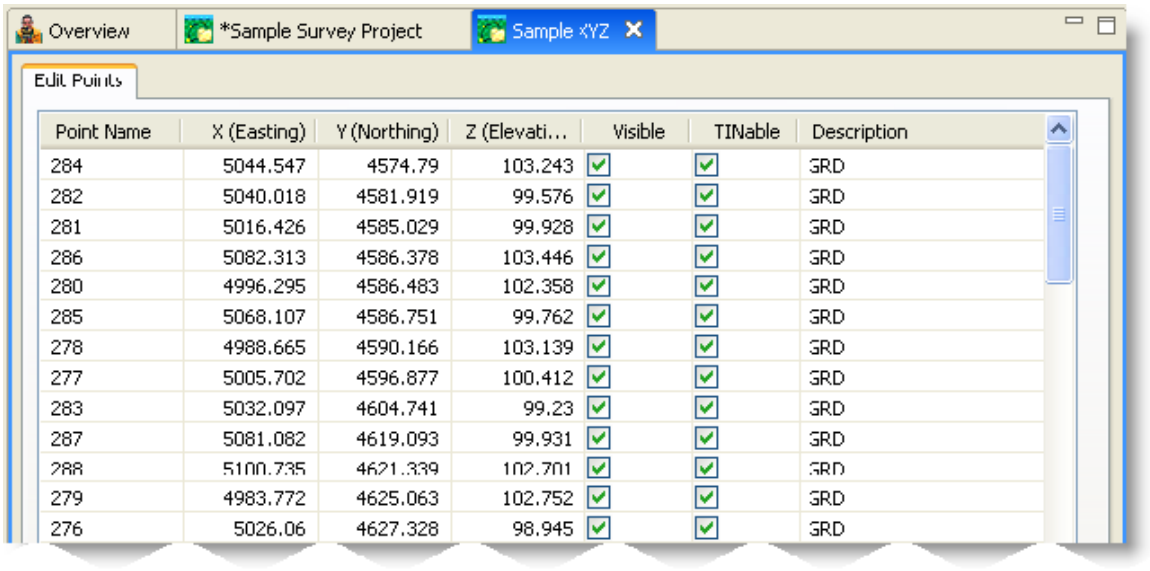
4. The Conversion Format window will appear, where you must select the format of the data in the imported file. After selecting the format, press FINISH.



5. If the file contains duplicate points, then they will be listed. Select the point that you wish to remain on the DTM by checking the box. The first one surveyed will be the default selection. The other non-checked points will be marked invisible and untinnable (will not be a part of the DTM).

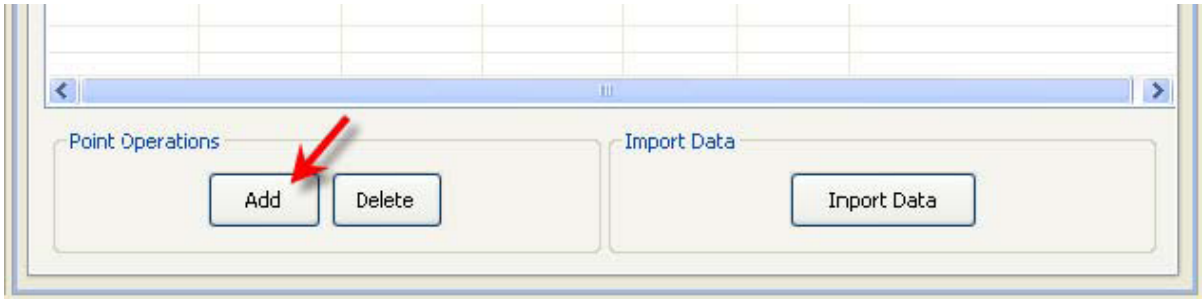


6. Click OK, and the XYZ data points will be displayed in the XYZ point table.

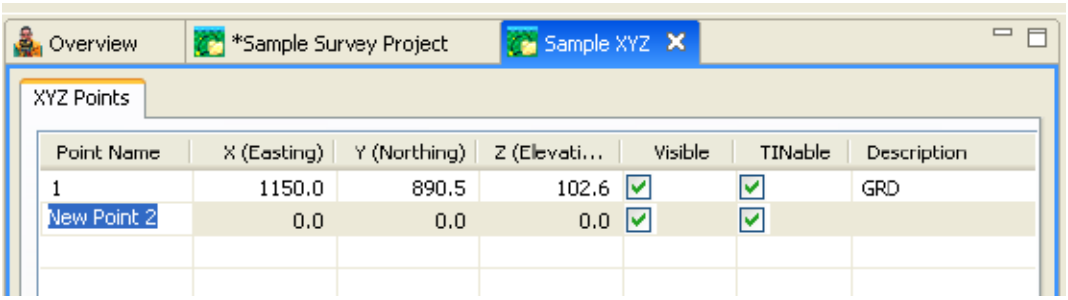


10.2.1.1.2. Manual entry

1. Click on the ADD button in the Point Operations portion of the Input Editor Screen.



2. The first row is highlighted so you may enter the point information. Enter the point coordinates and the description. The points will be Visible and TINable by default. You may change either of these by unchecking the box.



3. Continue adding points for your entire survey.

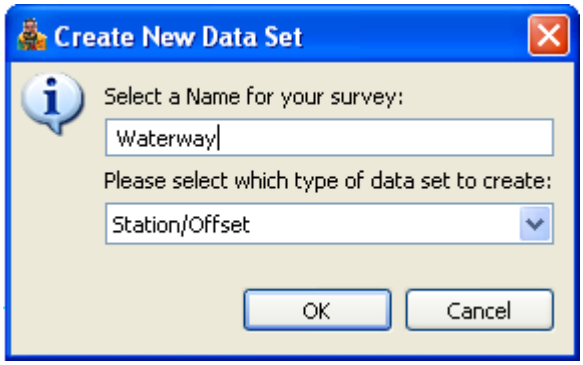
Note

The DTM will not be processed (contours will not be displayed) until the Survey Input Editor is closed. Do this by closing the Survey Editor Tab.

10.2.2. Station Offset Survey Input

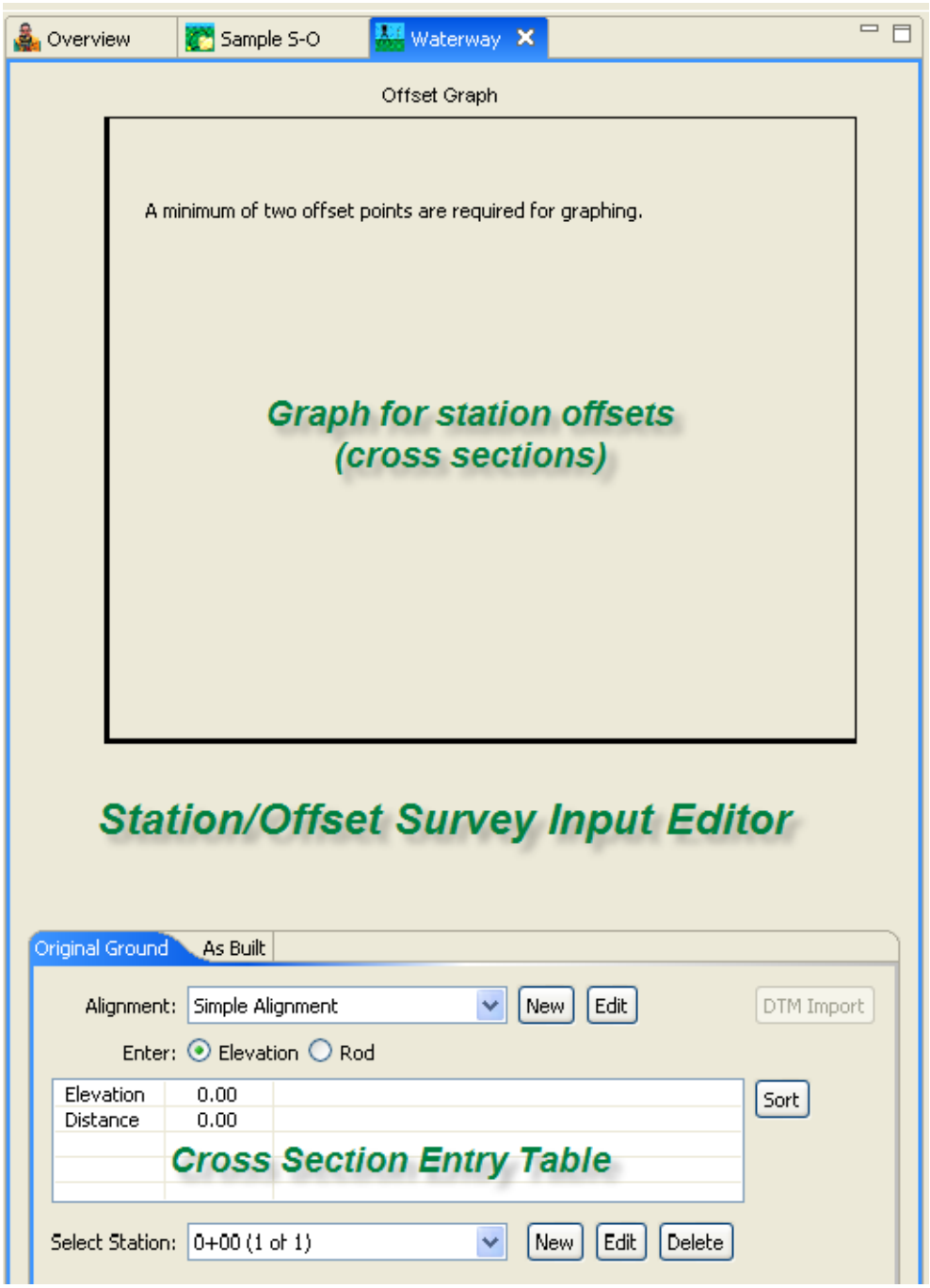
10.2.2.1. Create a New Station Offset Survey

Enter the name of this survey in the pop-up window, and be sure Station Offset is shown in the Survey type drop-down list. Click OK, and the Station Offset Input Editor will open.

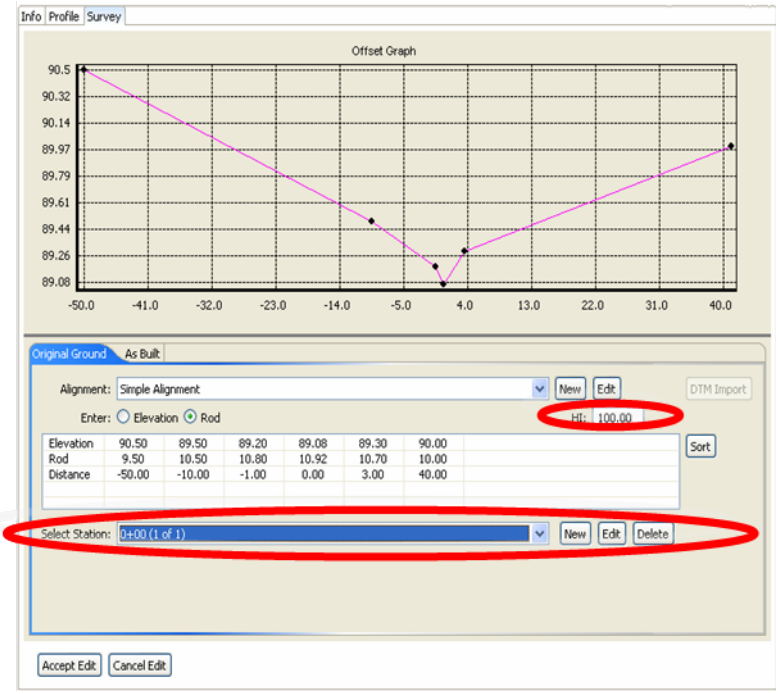


10.2.2.2. Station-Offset Survey Input Editor

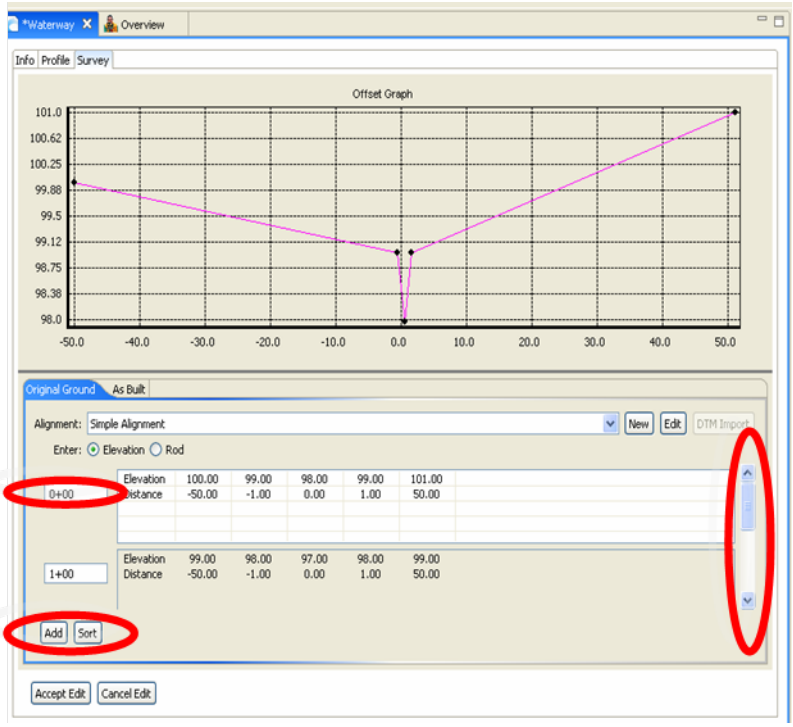
The Station Offset Survey Input Editor opens with the Offset graph at the top and the cross section (offset) entry table at the bottom, as shown below. Before sections are entered, an alignment is needed, as described in the next section.



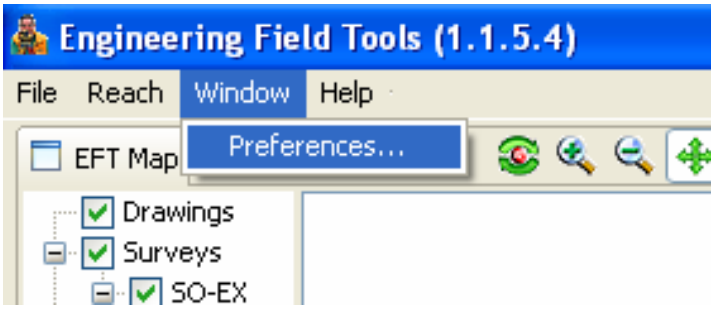
There are two different styles of Station Offset entry: the **Single Table** method and Scrolling Table method. The Single Table method shown below, has only one set of offset survey data on the table at a time. The user can choose from a drop down menu which station offset to edit.

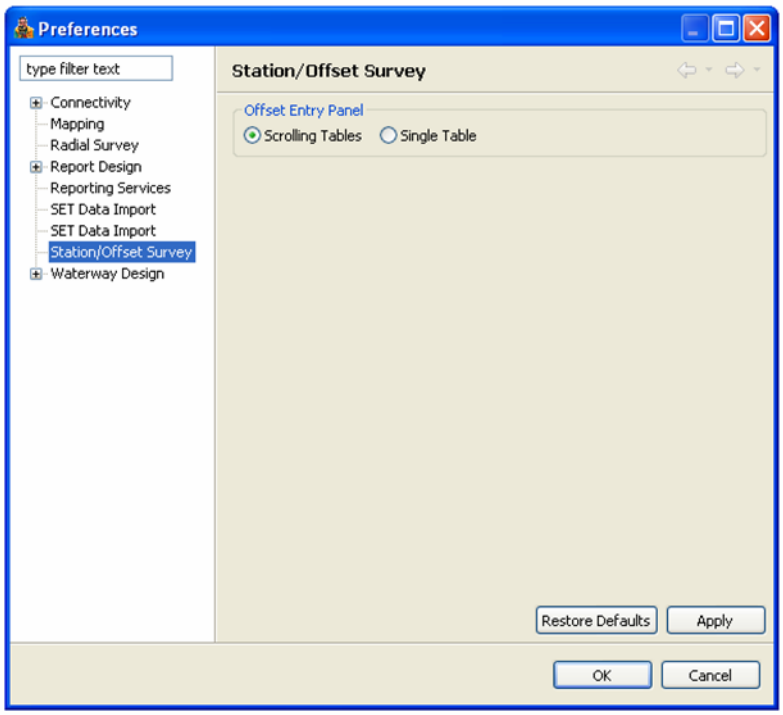


The **Scrolling Table** method shown below, has multiple offset survey data sets on the table at a time. The user can use the scroll bar at the right to view parts of the table not currently displayed.

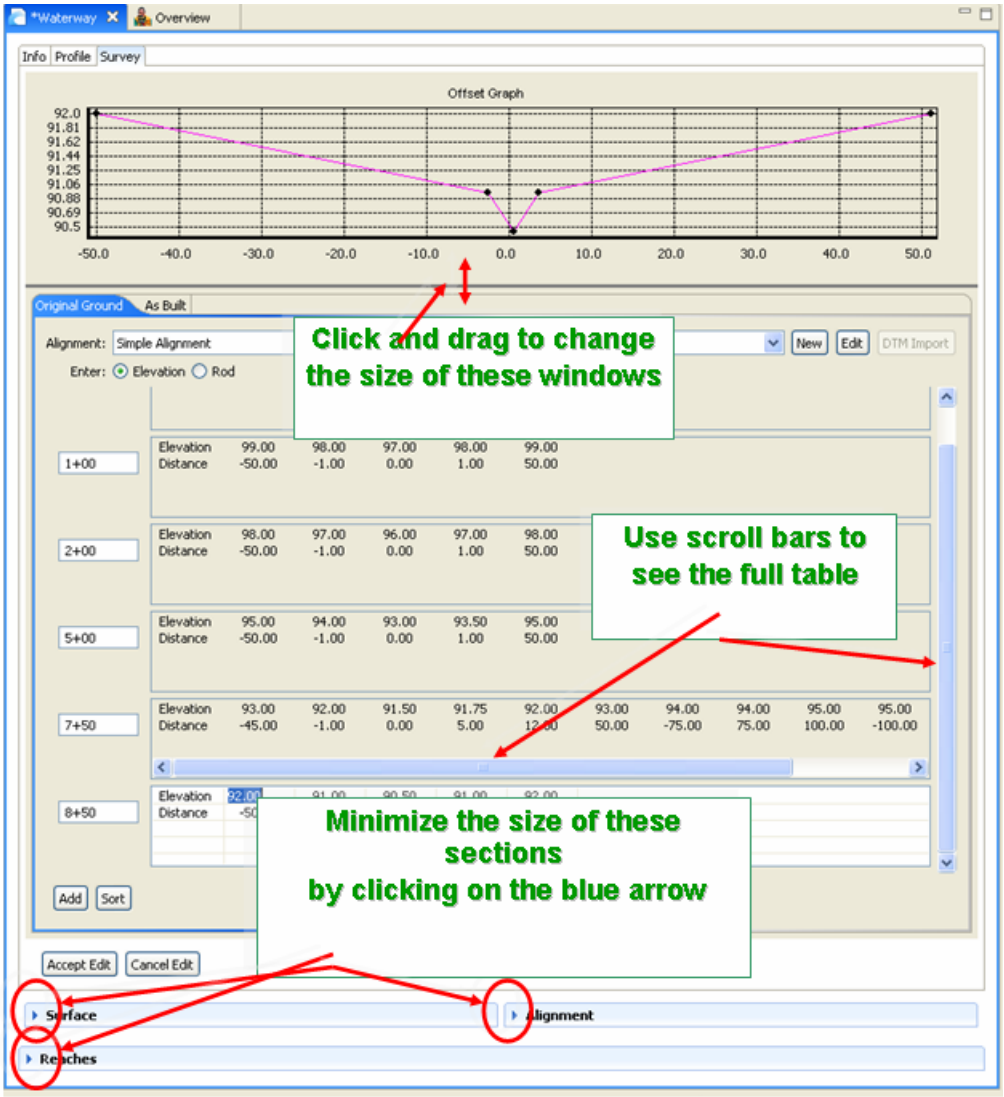


In order to change the Station Offset Entry Method, click on Windows, then Preferences, then Station/Offset Survey to select the desired entry method.



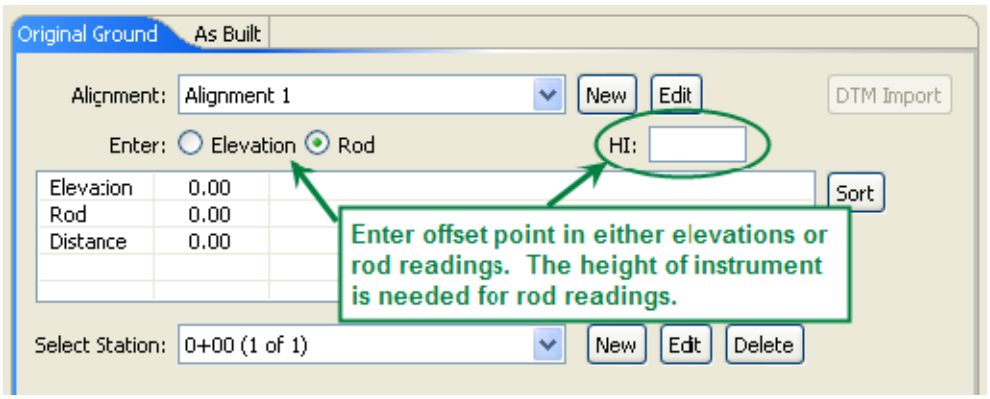


The survey screen can be adjusted to allow more viewable area by dragging the sides of windows to achieve the desired size. The Surface, Alignment, and Reaches sections can be minimized by clicking on the blue arrows.

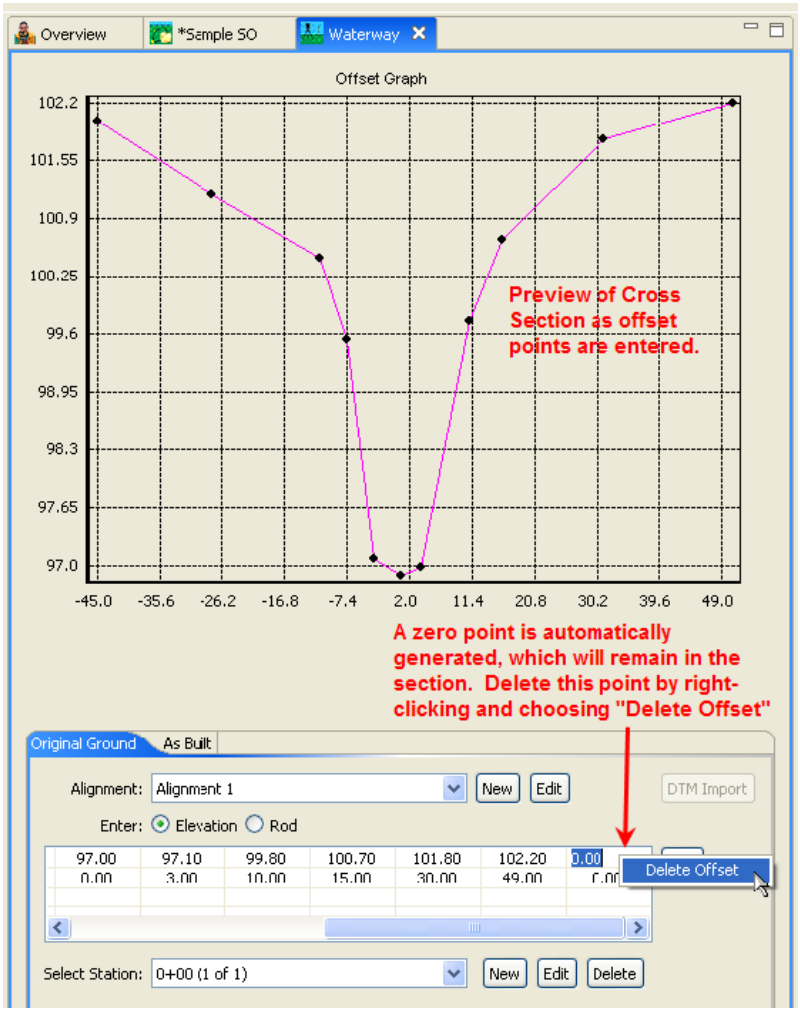


10.2.2.3. Entering offset data

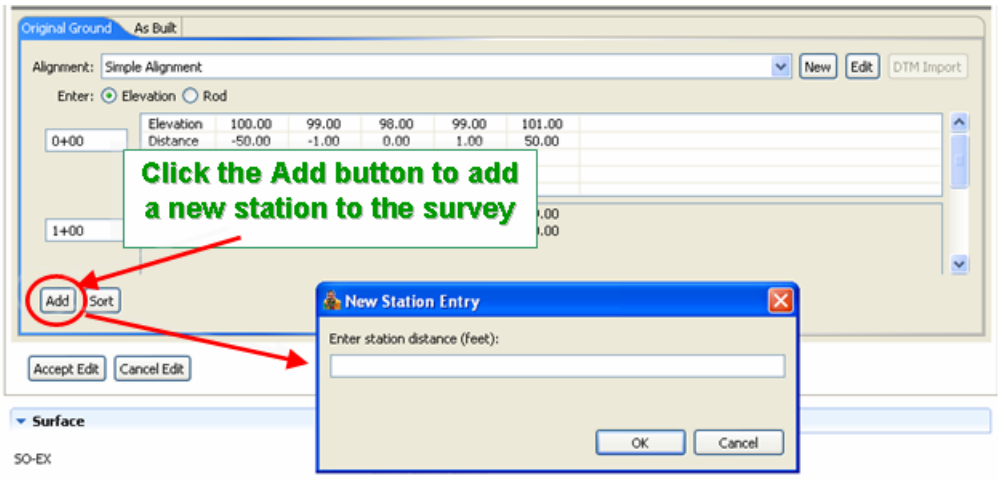
Once the alignment is defined (or the simple alignment is used), begin entering cross section (offset) points. Enter your point data using rod readings or elevations. Enter an HI elevation to compute cross section elevations from rod readings. Use the Enter or Tab keys to advance through the table. After you enter a distance, hitting the Enter or Tab key will insert a new column into the table for entry.



As you enter the offset data, the Offset Graph will show the cross section. Note that a zero point is created after each point is entered. You must delete this point when you are done with the section. Do this by right clicking on the point (with either field active), and choose **Delete Offset**. The graph will now look correct.

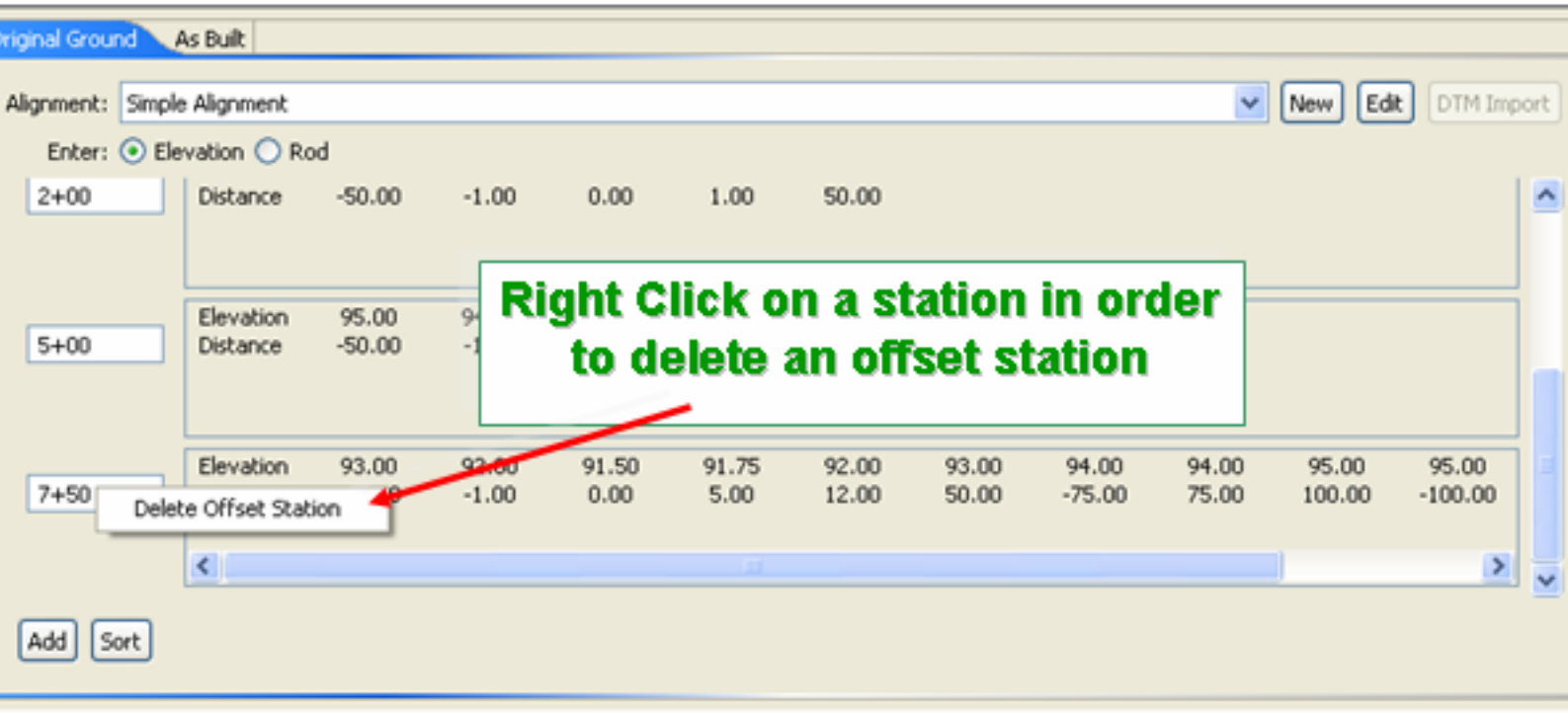


To enter the next cross section, press the **Add** button to the right of the Select Station field.



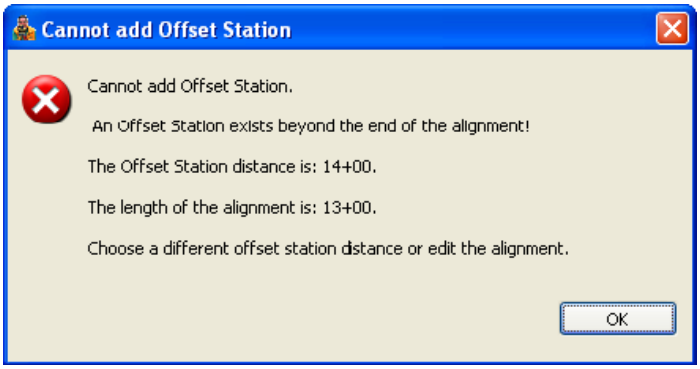
Fill in the station of the next cross section. Do not add the "+" symbol to the station; the program will do this.

Delete cross sections by right clicking on the station number and selecting the delete offset station selection.

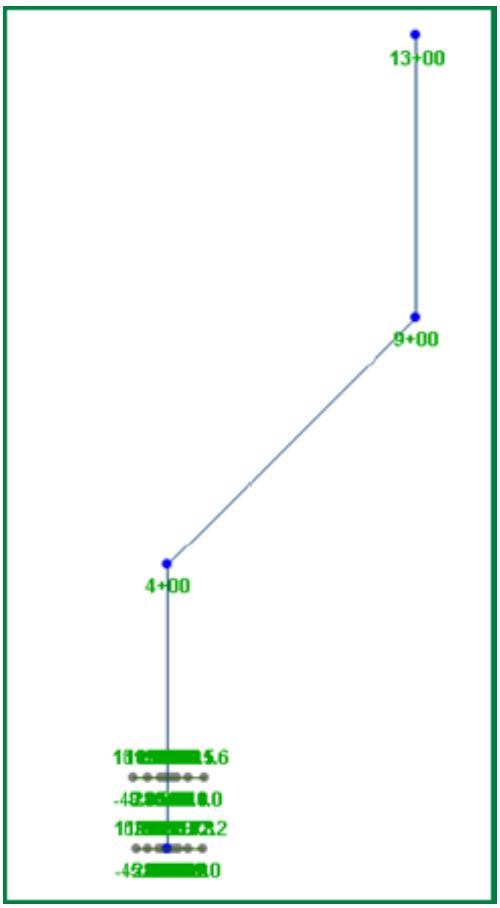


Note

If you are using the Simple Alignment, the alignment will extend automatically to accommodate the station distance. However, if you have defined an alignment, new cross section stations must be in the range between the beginning and ending station (as defined in the Alignment Editor). Otherwise, an error message will be displayed (sample message below). If you need to enter a station that is before the beginning station or beyond the ending station of an existing alignment, then you must first edit the alignment to lengthen it.



As you enter sections in the Input Editor, the survey map will display the alignment and offset data, along with the point information. Note that this is not the DTM. The DTM will be generated when the input editor is closed for the survey.



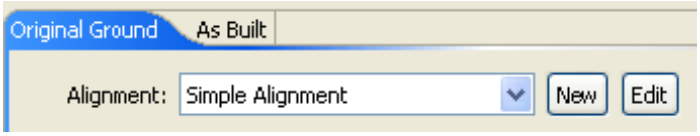
Note

The DTM will not be processed (contours will not be displayed) until the Survey Input Editor is closed. Do this by closing the Survey Editor Tab after all station offset data has been entered.

10.2.2.4. Station Offset Alignments

There are two types of Station Offset alignments in WDT: Simple alignment and User-defined alignment.

10.2.2.4.1. Station Offset Simple Alignment



When a new station offset survey is opened, a simple alignment is assumed. The properties of a simple alignment are as follows.

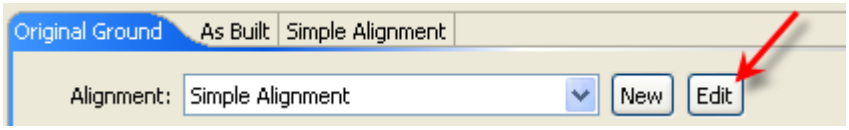
- Starting station = 0+00
- Increasing stations oriented towards the North (zero degrees azimuth)
- Straight alignment, without deflections or curves
- Beginning station centerline coordinates of X=0 and Y=0

If a simple alignment can be used, then you can simply begin entering cross-section data (see ‘‘Entering Offset Data” below). However, if any of the properties do not apply to your alignment, then you must define an alignment.

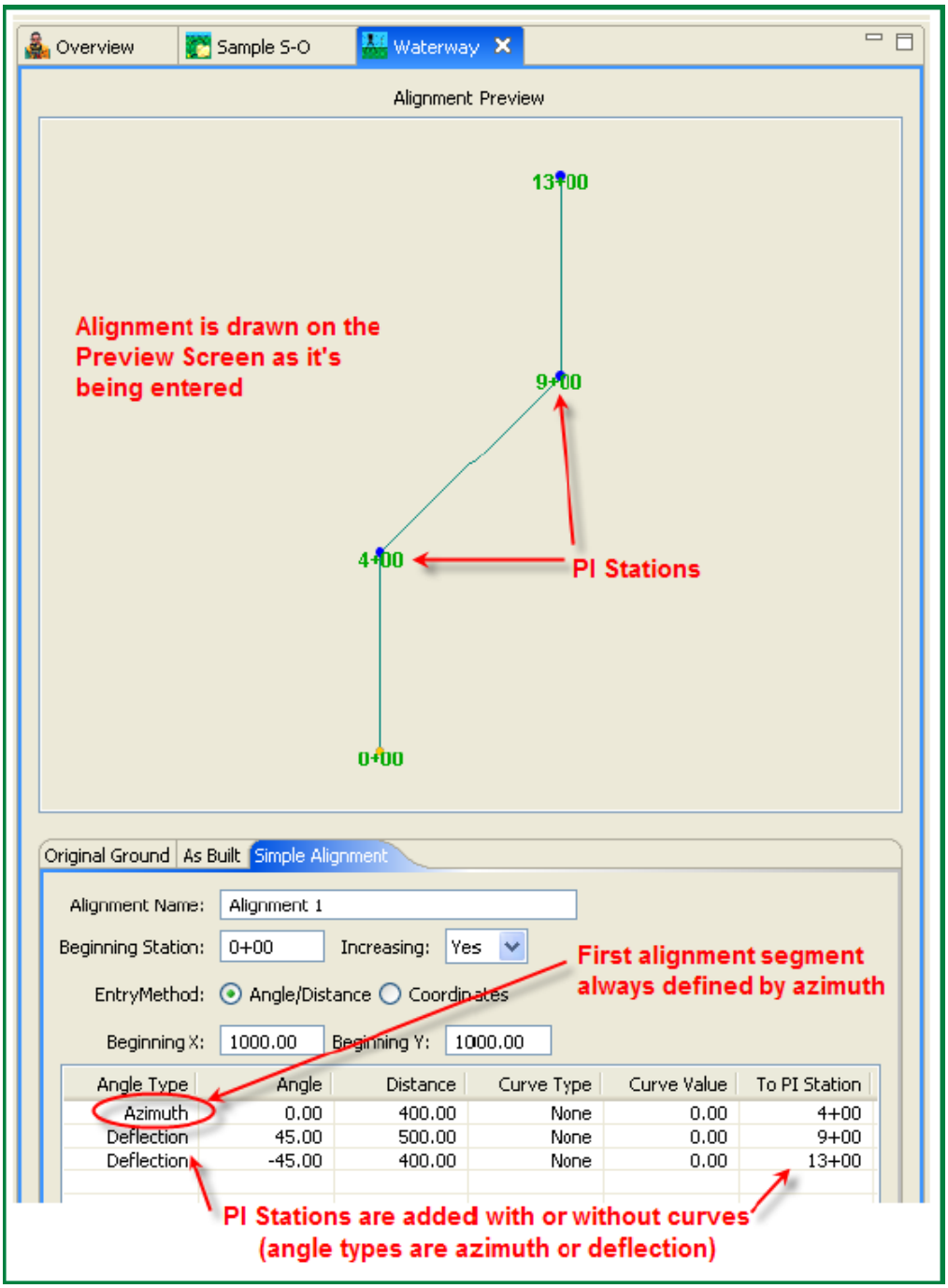
10.2.2.4.2. Station Offset User Defined Alignment

User defined alignments give full flexibility in defining the alignment, including defining the starting station, beginning X & Y coordinates, and the ability to defined alignments with deflections or curves at any azimuth.

To begin an alignment, click on the Edit button. This will replace the Simple Alignment rather than add another alignment to it.



An Alignment Editor Screen will appear to allow entry of the parameters to define the alignment as shown on the next page.



Enter the following information as it applies to your new alignment:

1. Enter a new name for you alignment. The program will not allow you use the name “Simple Alignment”.

2. Enter a starting station for your alignment.

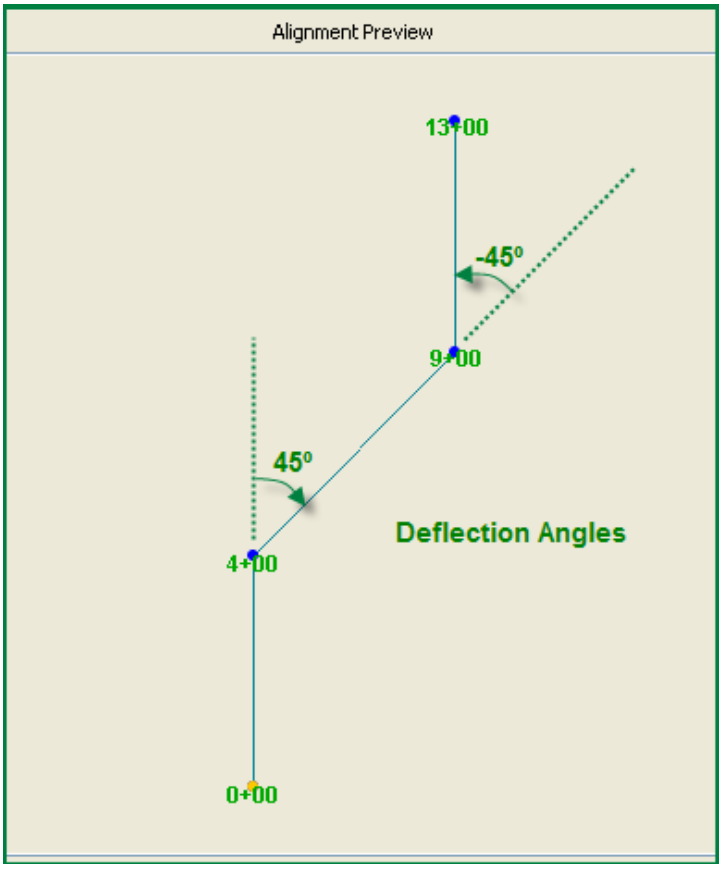
3. If stations will be decreasing from your starting station, choose No in the Increasing drop-down. Otherwise, leave as Yes.

4. Choose whether you will be defining your PI stations with angles and distances from the starting station, or by entering X & Y coordinates. Angle/Distance is the default.

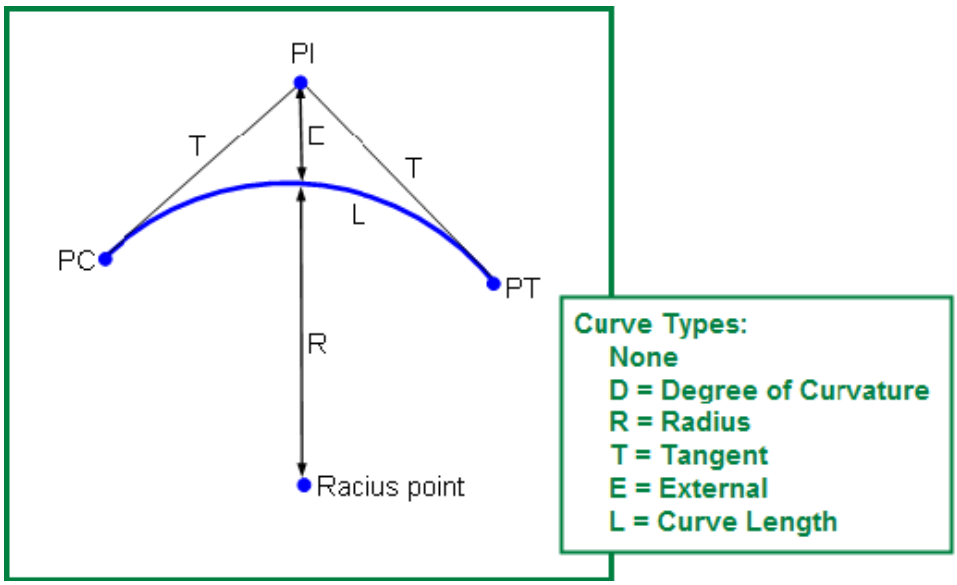
5. Enter the X & Y coordinates of the beginning of the alignment, if other than zero.

6. Begin defining the alignment by entering the parameters that will define the next PI station. Note that the first segment of the alignment must be defined by entering a starting azimuth (zero being north). Enter the azimuth angle and the distance to the next PI station. No curves are allowed on the first segment of the alignment. Note that angles are to entered in DD.MMSS format (for example, an angle of 45 degrees, 35 minutes would be entered as 45.35)

7. Continue adding data to define subsequent points in the alignment. Angles can be either azimuth or deflection. Deflection is the default angle type for the subsequent PI stations. The screen shot below illustrates deflection angles by showing the alignment as it was entered in the table on the previous page.

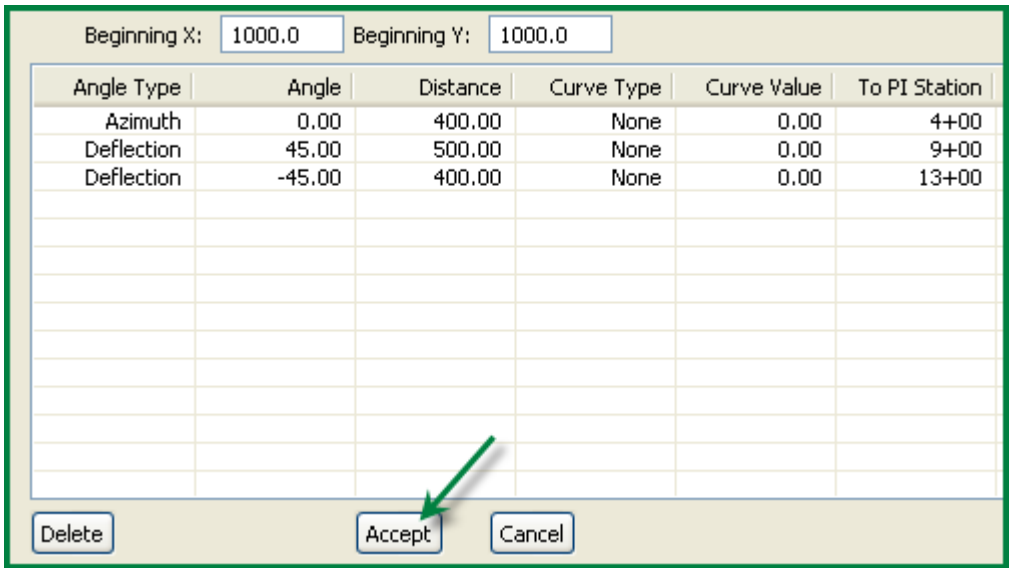


Alignments can have straight line segments, or can be defined by curve data. Each curve may be defined in one of several parameters; all of the other parameters will be computed. Note that the Arc Method is used to define the curves in SET. Refer to the Engineering Field Handbook, Chapter 1 for definitions and a full explanation of horizontal curves.



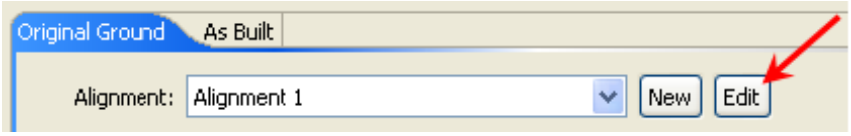
- None - no curve is simply a straight alignment to the next PI station
- Degree of Curvature - enter the degree of curve subtended by a chord of 100 feet
- Radius - enter the radius of the circle that describes the curve (in feet)
- Tangent - enter the distance from the PC to the PI (in feet)
- External - enter the external distance from the mid-point of the curve to the PI
- Curve Length - enter the distance along the curve from the PC to the PT

Once the alignment is entered, press the Accept button to save the alignment and return to the Input Editor.

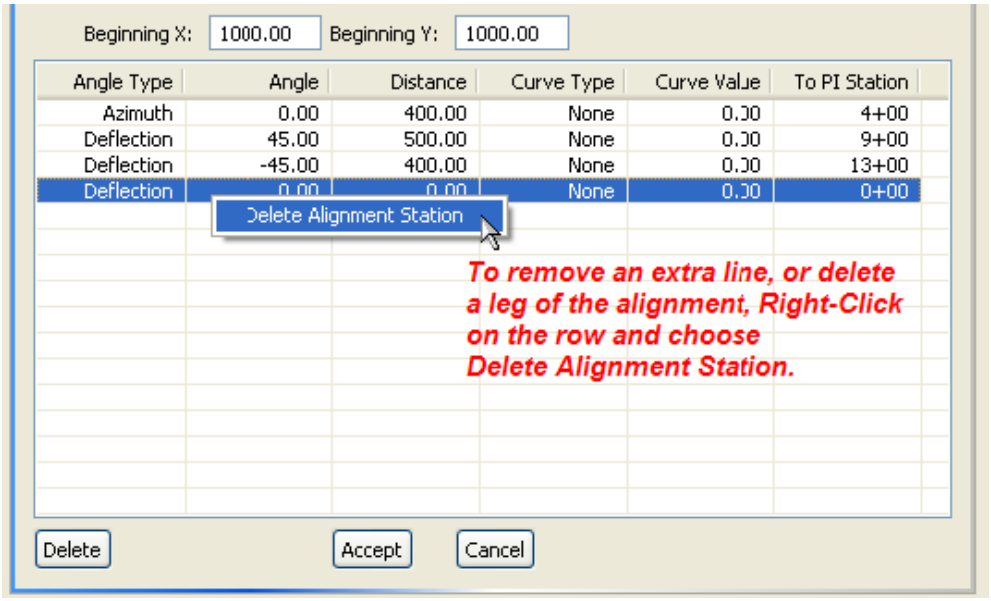


10.2.2.4.3. Station Offset Editing and Deleting Alignments

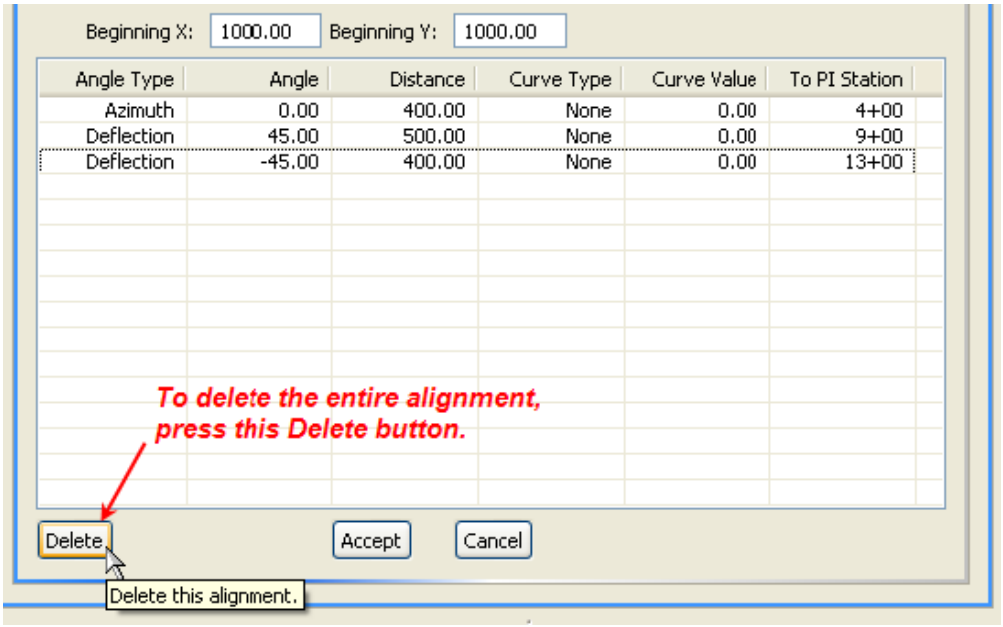
To edit an existing alignment, choose it from the drop-down box and press the Edit button.



You may edit the alignment by changing the values directly in the table. To remove a segment of the alignment (or to remove an extra row of data in the alignment screen), right-click and select Delete Alignment Station. Press the Accept button to save the changes, or the Cancel button to go back to the Offset Data screen without saving any changes.



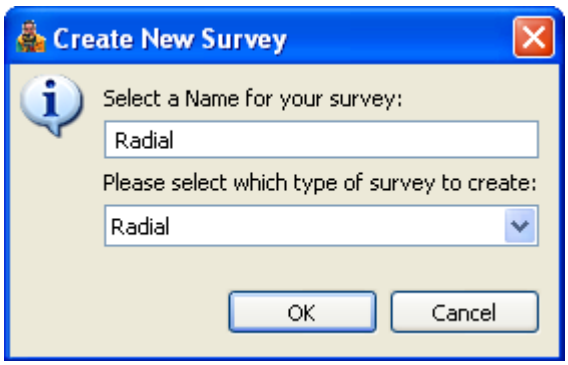
To delete the entire alignment, press the Delete button.



10.2.3. Radial Survey Input

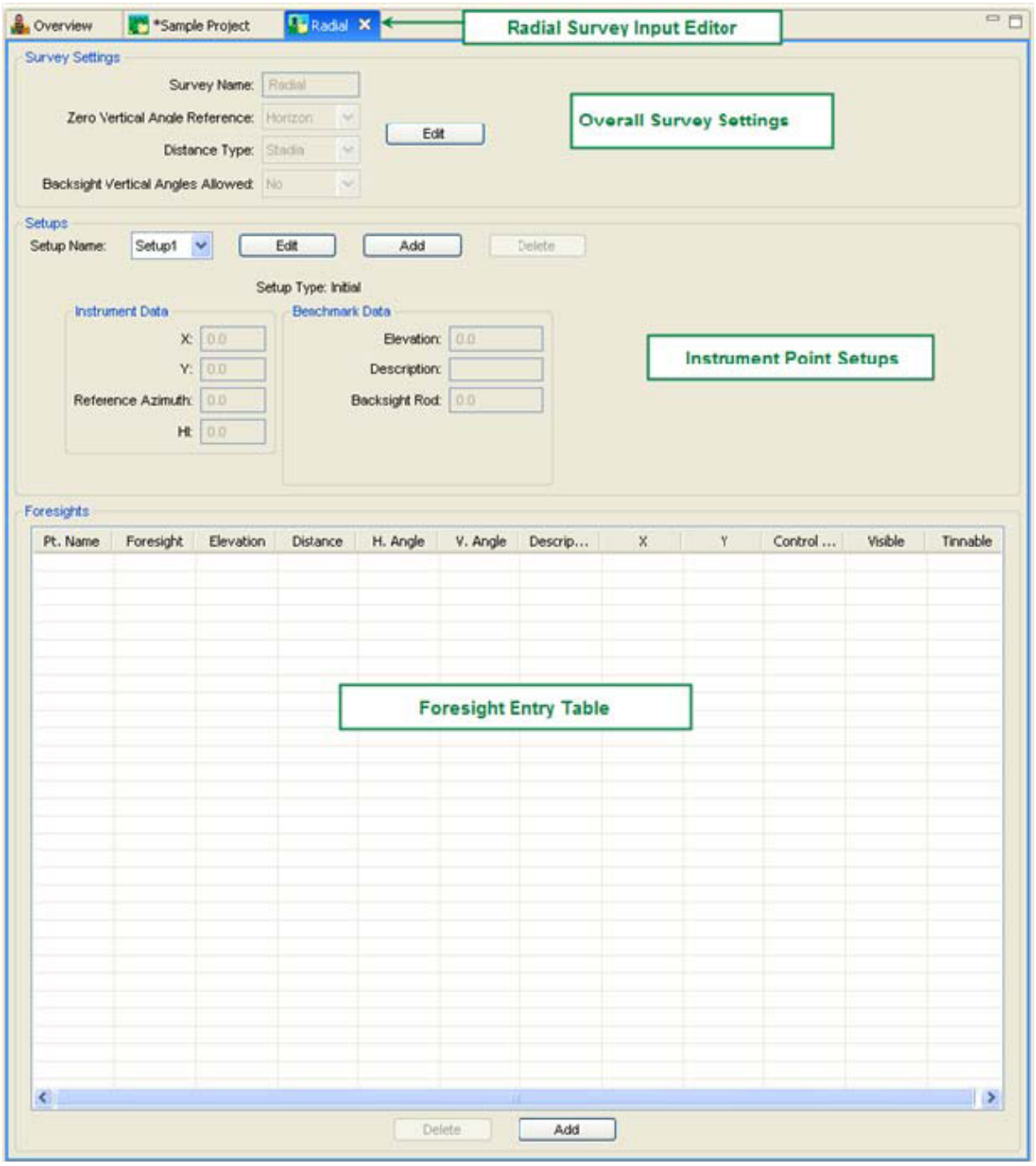
10.2.3.1. Create a New Radial Survey

1. Enter the name of this survey in the pop-up window, and be sure Radial is shown in the Survey type drop-down list. Click OK, and the Radial Input Editor will open.



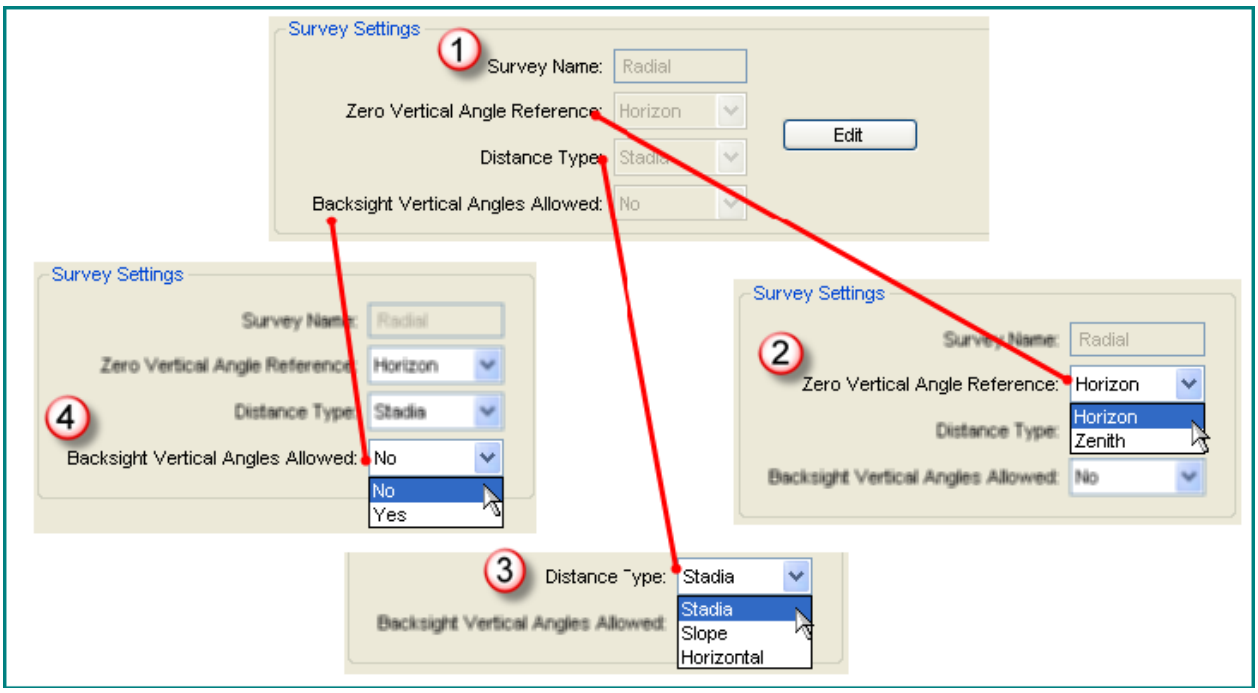
10.2.3.2. Radial Survey Input Editor

The Radial Survey Input Editor opens as shown below. The Survey Settings for the entire survey are shown at the top. The center section is where the Instrument Setup data is entered. The bottom section is where the Foresights are entered.



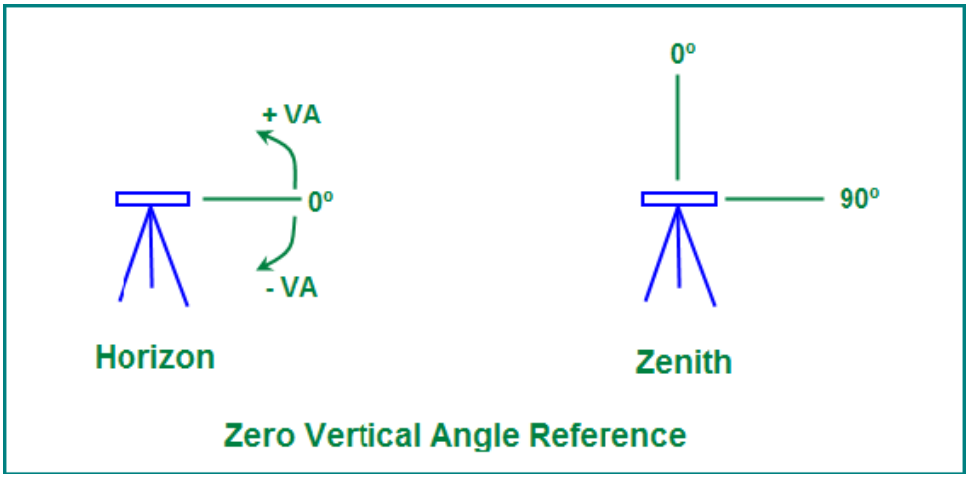
10.2.3.3. Survey Settings

The survey settings affect the entire radial survey. The setting choices are shown and described below:



1. Survey Name is as entered when creating the survey. The name cannot be changed here.

2. Zero Vertical Angle Reference refers to whether the zero degree reference for vertical angles points on the horizon or points straight up (Zenith). Horizon is the default reference. Vertical angles are entered differently depending on the reference chosen, as shown in the following schematic.

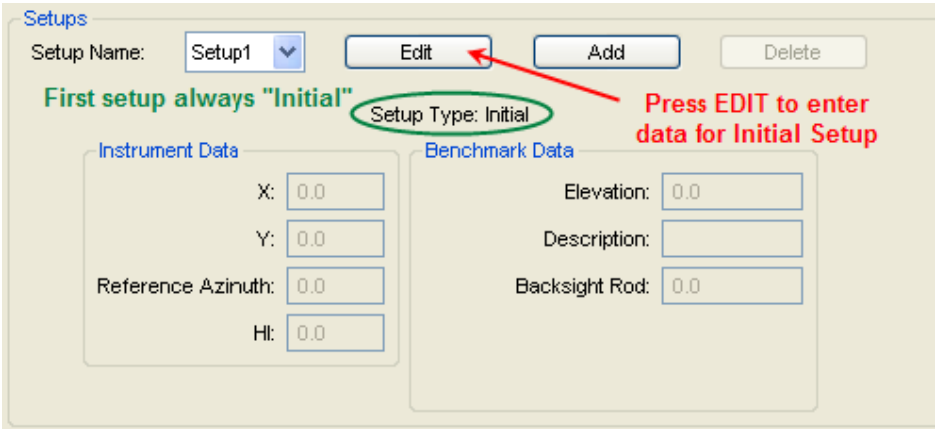


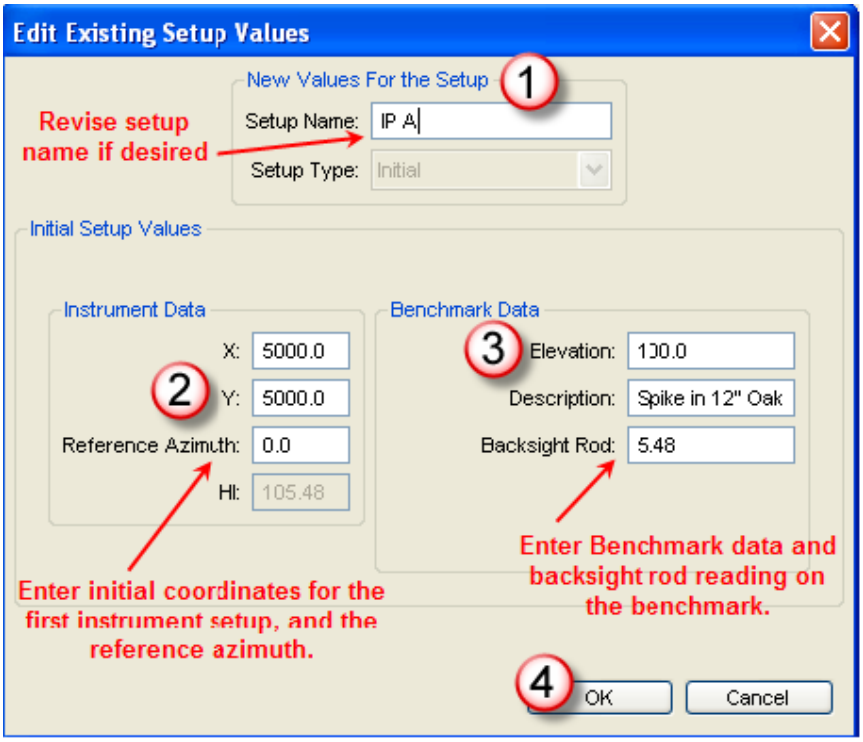
3. Distance Type refers to how the distance measurements are taken. The most common is Stadia distance, and is the default. If the slope distance or horizontal distances were measured, then choose the appropriate type.

4. Backsight Vertical Angles Allowed asks you whether or not vertical angles were taken on backsight shots from TBMs or TPs. Using vertical angles on backsight shots is not normally good survey practice but is sometimes necessary. The default is No.

10.2.3.4. Initial Setup

The name of the first instrument setup type in a radial survey is always called the **Initial** setup. To enter the specific instrument data and backsight data for the initial setup, press the **Edit** key.





1. You may change the name of the initial setup if you wish.

2. Enter the X and Y coordinates of the instrument and the reference azimuth. For instance, if you set the zero azimuth of the instrument to magnetic north, then enter zero degrees as the reference azimuth.

3. Enter the Benchmark Data: the elevation and description of the benchmark and the rod reading of the backsight shot taken on the benchmark.

4. Press OK to accept the Setup values for the Initial Instrument Setup.

10.2.3.5. Foresights table

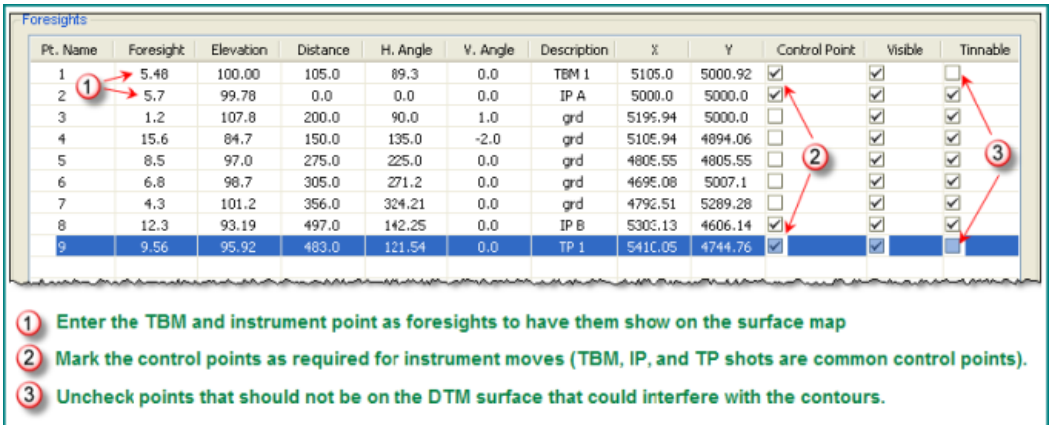
Now, you are ready to enter foresights taken from the first instrument point. First, press the **Add** button; then, enter the foresight data. The point name is automatically incremented (P1, P2, etc), but you can overwrite the name if you wish. Pressing the **Tab** key or the **Enter** key will advance the cursor to the next field. The elevation and X and Y coordinates of each shot are computed as the data is entered.

10.2.3.6. Point Attribute Checkboxes

1. **Including Benchmark and Instrument Points on the Map** — To include the initial benchmark and instrument point on the map, you will need to enter them as foresight shots as shown below.

2. **Control Points** — If the survey involves more than one instrument point, then certain foresights will need to be marked as control points. Control points are those locations that will be sighted from future instrument points for either vertical or horizontal control. Examples are benchmarks, turning points, and instrument points. Simply click the control point checkbox to mark points as control points. Uncheck the box to unmark them.

3. **Visible and Tinnable Points** — You have the option to exclude certain points from the surface map by making them invisible. An example might be a check shot on a benchmark that might clutter the map. You also can make points untinnable, which means that they will be visible but will not be included on the DTM. Examples are benchmarks and turning points that are not on the ground and could bias the contour map. Click the checkboxes to mark the points. Note that invisible points are automatically marked untinnable, and conversely tinnable points must be visible.

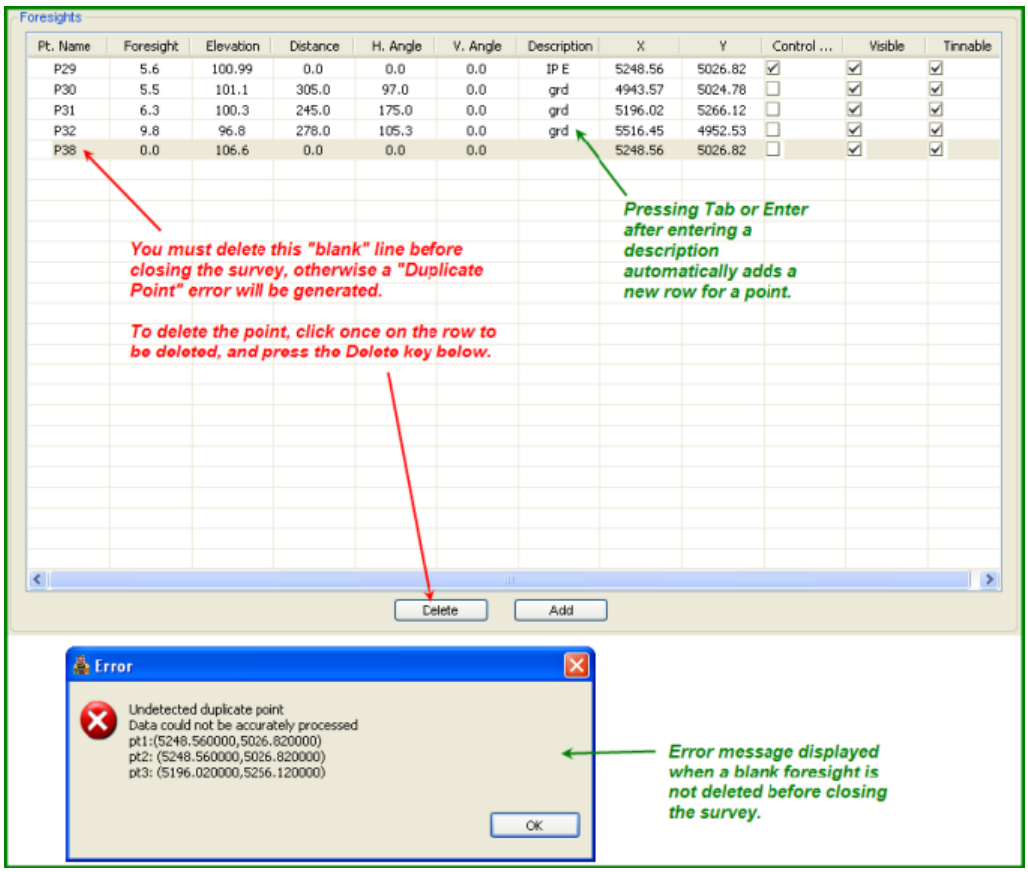


10.2.3.7. Deleting Foresights

To delete foresight shots, simply click on the row containing the foresight entry and press the Delete key.

Note

As you enter foresight shots, a new row is automatically generated with the next available point number and with zero entries. If the previously entered foresight was the last to be entered in the table, then this blank row must be deleted, or duplicate points will exist and an error message will be generated when you close the survey. Again, to delete this foresight, click on the row and press the Delete key. In the example below, if point P32 is the last point to be entered in this table, then the blank foresight must be deleted.



Note

The DTM will not be processed (contours will not be displayed) until the Survey Input Editor is closed. Do this by closing the Survey Editor Tab after the radial survey data has been entered.

10.2.3.8. Instrument Move Types

Four types of instrument moves are supported by SET. With all of these methods, the horizontal orientation is maintained throughout the survey.

1. **North at Point** —The most common method is when the surveyor shoots a new point to where the instrument will be moved. First, a turning point is shot to transfer elevation. Then the next instrument point is shot, and the inner base plate of the instrument (horizontal orientation) is locked. The instrument is then moved to the new point. By plunging the scope and aligning the outer base plate on the previous point, the original reference position for horizontal angles is maintained throughout the survey. The surveyor will then lock the outer baseplate, unlock the inner baseplate, replunge the scope, then backsight on the turning point to establish the height of instrument (HI) at the new instrument point. Now the instrument is ready to shoot additional points (foresights). For those who are familiar with the Ohio SSRP program, this instrument move was called “Orient on North from Predetermined Point (plunge).”

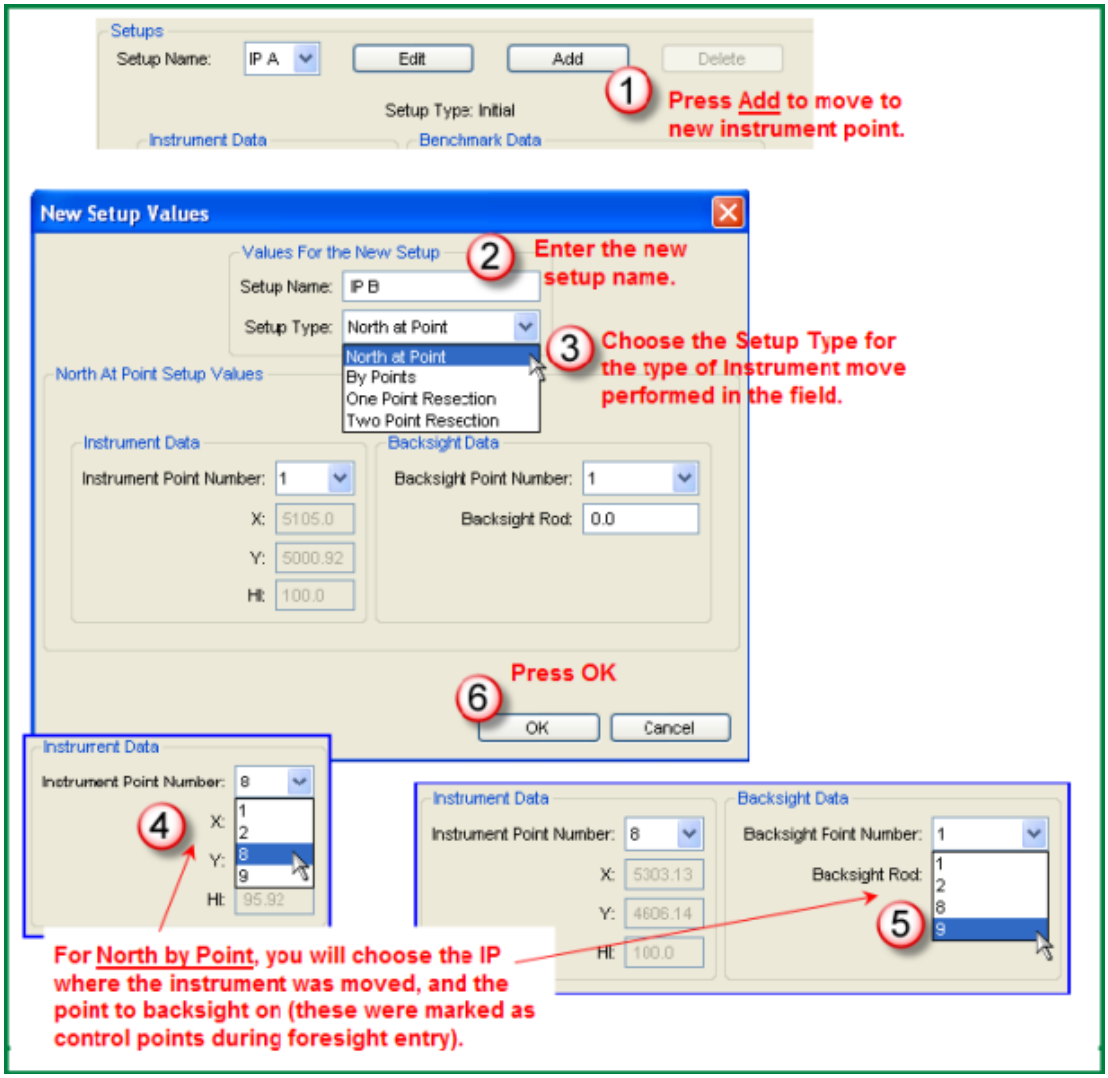
2. **By Points** — This is similar to the previous method (instrument is moved to a previously surveyed point), but instead of plunging the scope, you may Zero the reference position on any existing point. In this case, the measured horizontal angle is not the typical north azimuth angle. In SSRP, this was called “Previously Surveyed Point with a New Orientation.”

3. **One Point Resection** — This is where the instrument is set up on a random unknown point. The horizontal reference angle is set via the compass to magnetic north. Then a known point is shot (horizontal angle and distance). This provides the position of the instrument. The same point also serves as the turning point for elevation, so shooting this point is treated as a backsight. In SSRP, this method was called “North Orientation with Instrument at a Random Point.”

4. **Two Point Orientation** — This last method is similar to One Point Resection, except that distance and angle are measured to two known points. The position of the new point and reference orientation are calculated from these two points. Note that the second point is treated as a backsight so that the elevation can be computed. In SSRP, this method was called “2 Point Orientation with Instrument at a Random Point”.

10.2.3.9. Adding Instrument Setups (Moves)

To add a new instrument setup, follow the steps below:



1. Press the **Add** button in the Setups section of the Radial survey editor. The New Setup Values window will display.

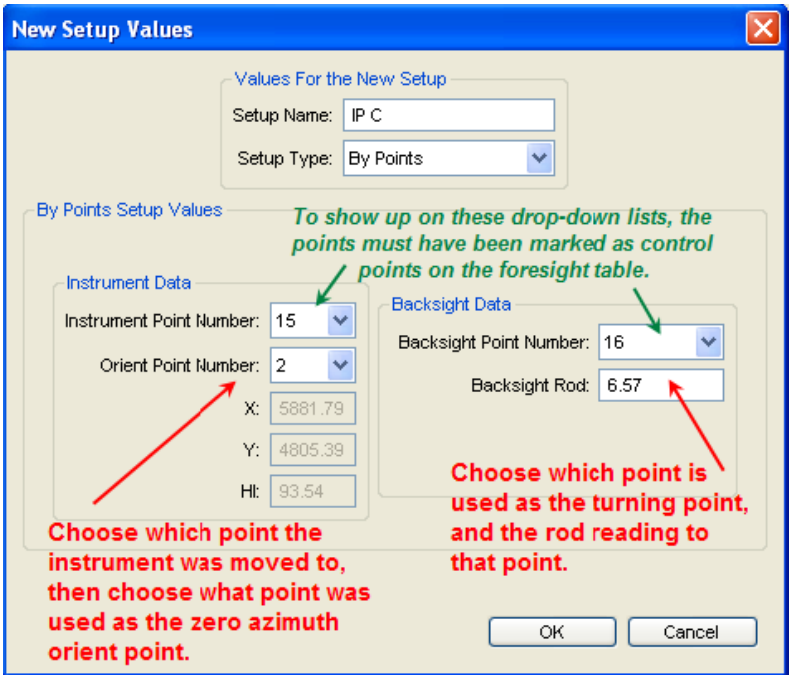
2. Enter a new setup name or accept the default name presented.

3. Choose the Setup Type that represents the method of moving the instrument performed in the field. The Instrument and Backsight data to be entered will depend on the type of instrument move:

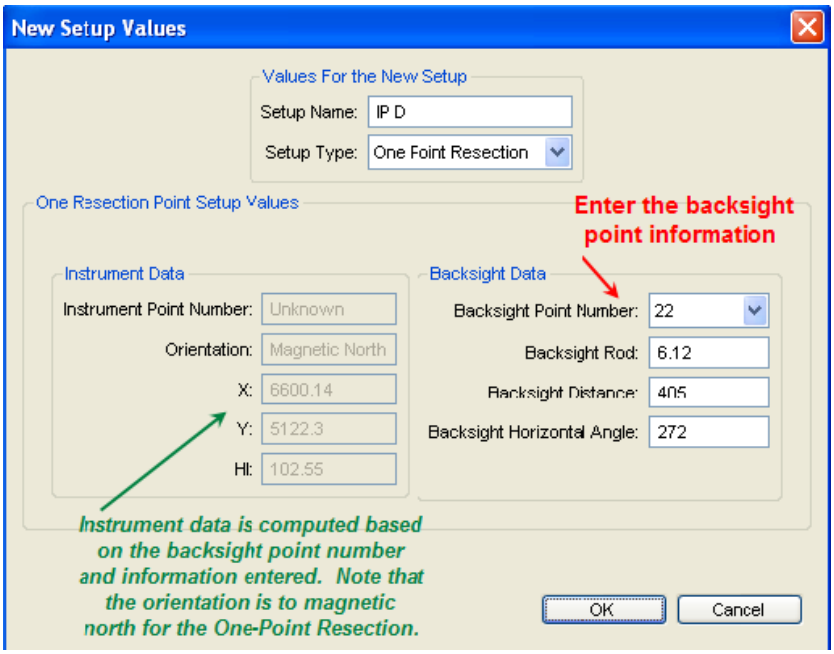
   a. **North at Point** (shown above) — choose the point number that the instrument was moved to from the drop-down list. This point was surveyed from the previous instrument location. Note that to be listed on this drop-down list, the point must be marked as a control point in the foresight table when the point was entered (if you forgot to mark the point, you must go back and check the Control point box in the foresights table where the point was entered). Next, choose the backsight point number, and the backsight rod reading. Then press OK. A new foresight table for this new instrument setup will be shown.

   b. **By Points** — for this instrument move type, choose the point number that the instrument was moved to from the drop-down list. Also, choose the orient point number (where the instrument was set to zero azimuth).

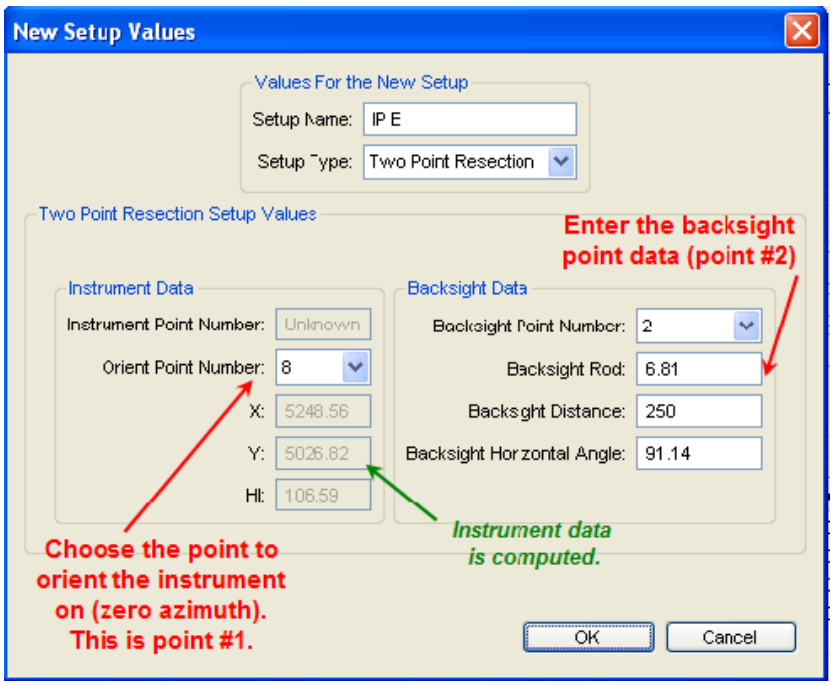
Next, choose the backsight point number, and the backsight rod reading. Then press OK. A new foresight table for this new instrument setup will be shown.



c. **One Point Resection** — For this move type, the instrument is set up at an unknown location, which will be computed. You must choose the backsight point number from the drop-down list, then provide the rod reading, distance, and horizontal angle from the instrument to the backsight point. *Note that the zero azimuth reference angle is assumed to be pointed to magnetic north for this instrument setup type.* Then, press **OK**. A new foresight table for this new instrument setup will be shown.

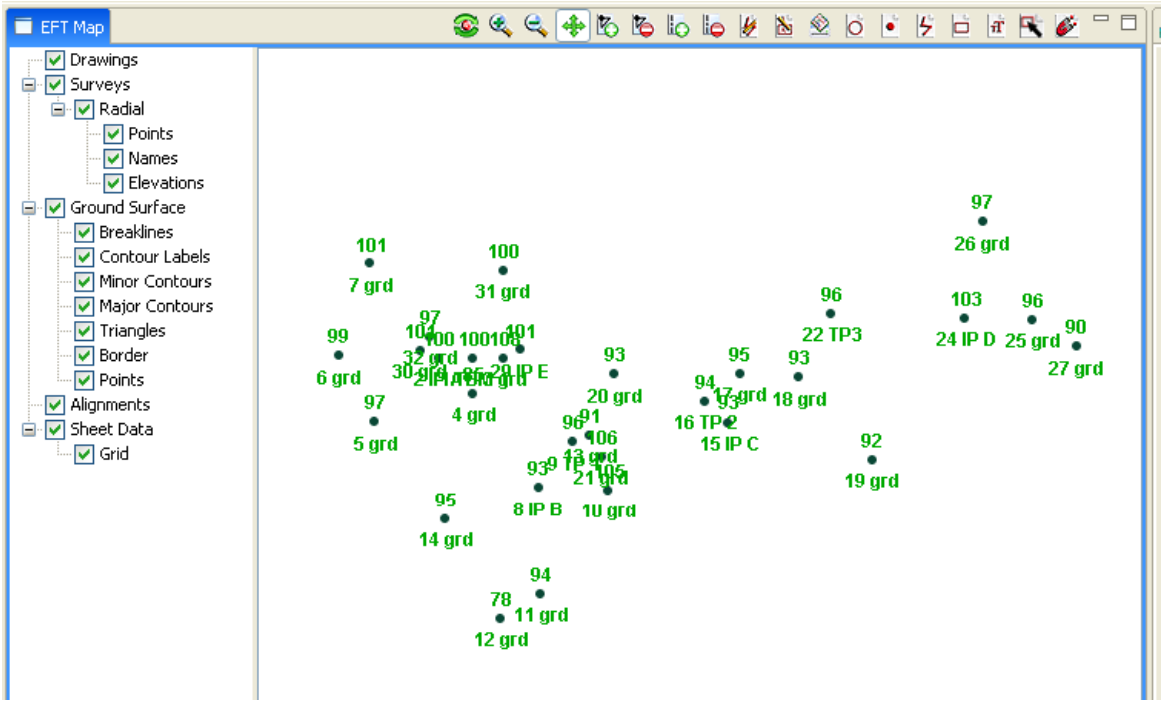


d. **Two Point Resection** — Like the one point resection, the instrument is set up at an unknown location which will be computed. The difference is that the instrument is oriented (zero azimuth) on a known point instead of magnetic north. Choose this orient point from the drop-down box. Then, choose the backsight point number from the drop-down list and provide the rod reading, distance, and horizontal angle from the instrument to the backsight point. Then press **OK**. A new foresight table will be shown.

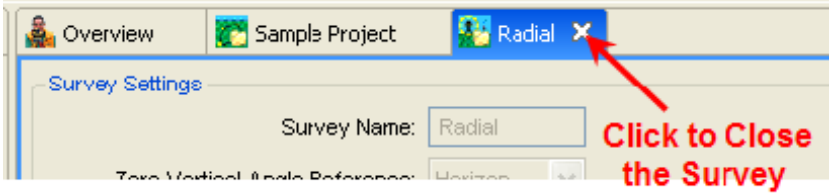


10.2.3.10. Survey Map

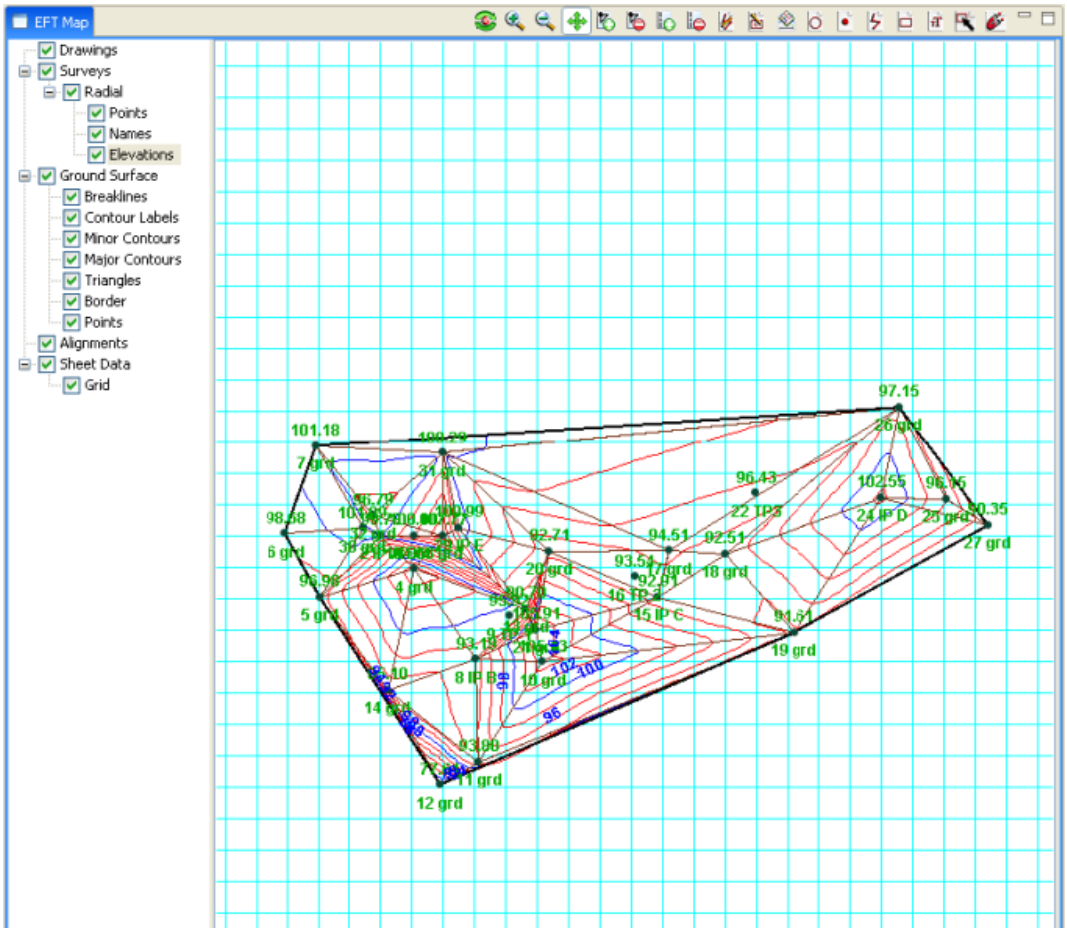
As the radial survey is entered, the points are displayed on the map. While the radial survey is open, the DTM will not be processed. Note that you may need to press the FULL EXTENT button first to see the points.



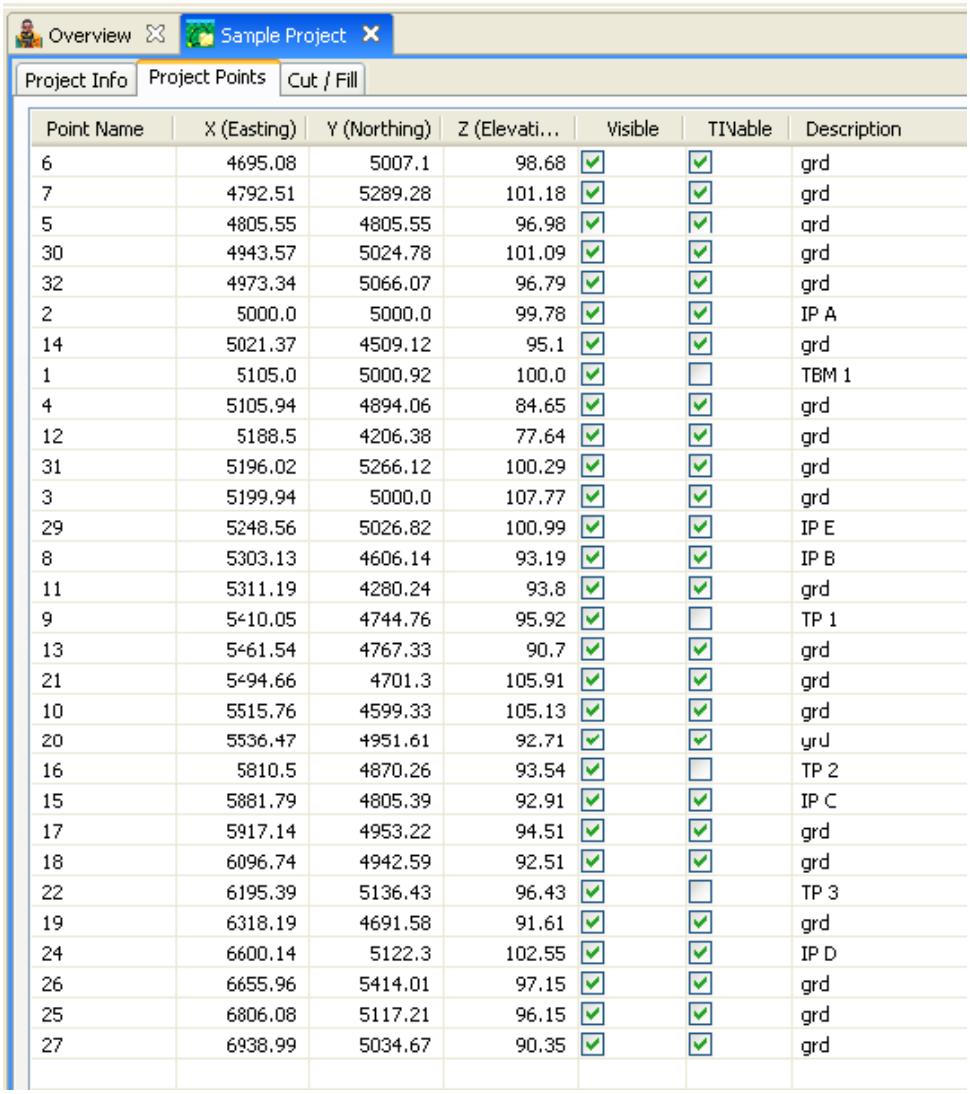
To close the survey and display the contour map (process the DTM), click on the **X** on the survey name tab.



Now, the survey map screen will display the DTM of the radial survey. *Note that the radial survey and the ground surface have been added to the legend to allow control over what will be displayed on the map.*



Also, you can view the project points in X,Y,Z format by choosing the Project Points tab. Note that you cannot make changes to the points in this table. You must open the survey editor for the survey to be edited.

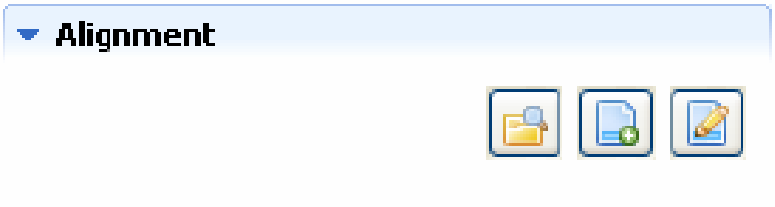


Point Name	X (Easting)	Y (Northing)	Z (Elevati...	Visible	TINable	Description
6	4695.08	5007.1	98.68	☑	☑	grd
7	4792.51	5289.28	101.18	☑	☑	grd
5	4805.55	4805.55	96.98	☑	☑	grd
30	4943.57	5024.78	101.09	☑	☑	grd
32	4973.34	5066.07	96.79	☑	☑	grd
2	5000.0	5000.0	99.78	☑	☑	IP A
14	5021.37	4509.12	95.1	☑	☑	grd
1	5105.0	5000.92	100.0	☑	☐	TBM 1
4	5105.94	4894.06	84.65	☑	☑	grd
12	5188.5	4206.38	77.64	☑	☑	grd
31	5196.02	5266.12	100.29	☑	☑	grd
3	5199.94	5000.0	107.77	☑	☑	grd
29	5248.56	5026.82	100.99	☑	☑	IP E
8	5303.13	4606.14	93.19	☑	☑	IP B
11	5311.19	4280.24	93.8	☑	☑	grd
9	5410.05	4744.76	95.92	☑	☐	TP 1
13	5461.54	4767.33	90.7	☑	☑	grd
21	5494.66	4701.3	105.91	☑	☑	grd
10	5515.76	4599.33	105.13	☑	☑	grd
20	5536.47	4951.61	92.71	☑	☑	grd
16	5810.5	4870.26	93.54	☑	☐	TP 2
15	5881.79	4805.39	92.91	☑	☑	IP C
17	5917.14	4953.22	94.51	☑	☑	grd
18	6096.74	4942.59	92.51	☑	☑	grd
22	6195.39	5136.43	96.43	☑	☐	TP 3
19	6318.19	4691.58	91.61	☑	☑	grd
24	6600.14	5122.3	102.55	☑	☑	IP D
26	6655.96	5414.01	97.15	☑	☑	grd
25	6806.08	5117.21	96.15	☑	☑	grd
27	6938.99	5034.67	90.35	☑	☑	grd

10.3. Edit Survey

There is also an option to edit the entered survey. If the survey was entered in station offset mode from within WDT, you will be able to edit the survey in station offset mode. If the survey was entered in SET, the survey may only be available for edit in XYZ format.

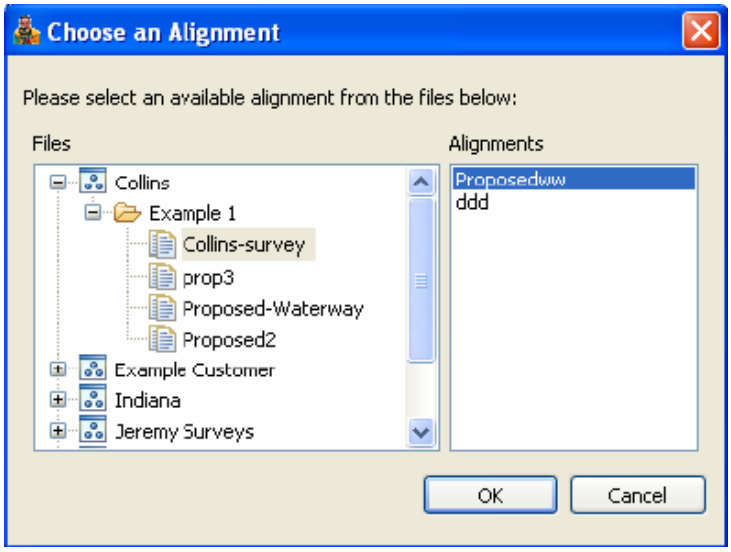
11. Alignment Box



Alignments are used within WDT to determine where on the survey the centerline of the waterway is located. WDT allows you to either select an alignment from an existing survey, create a new alignment, or edit the current alignment.

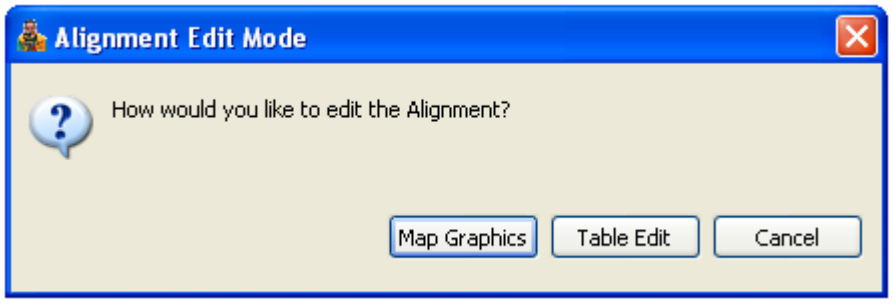
11.1. Select an Alignment

Selecting this icon allows you to select from surveys that have already been entered within SET. Select a survey from the pop-up window which will show the available existing surveys. Once a survey is selected, available alignments within that survey are displayed in the right window for selection. Select the desired alignment and click **OK** to continue.



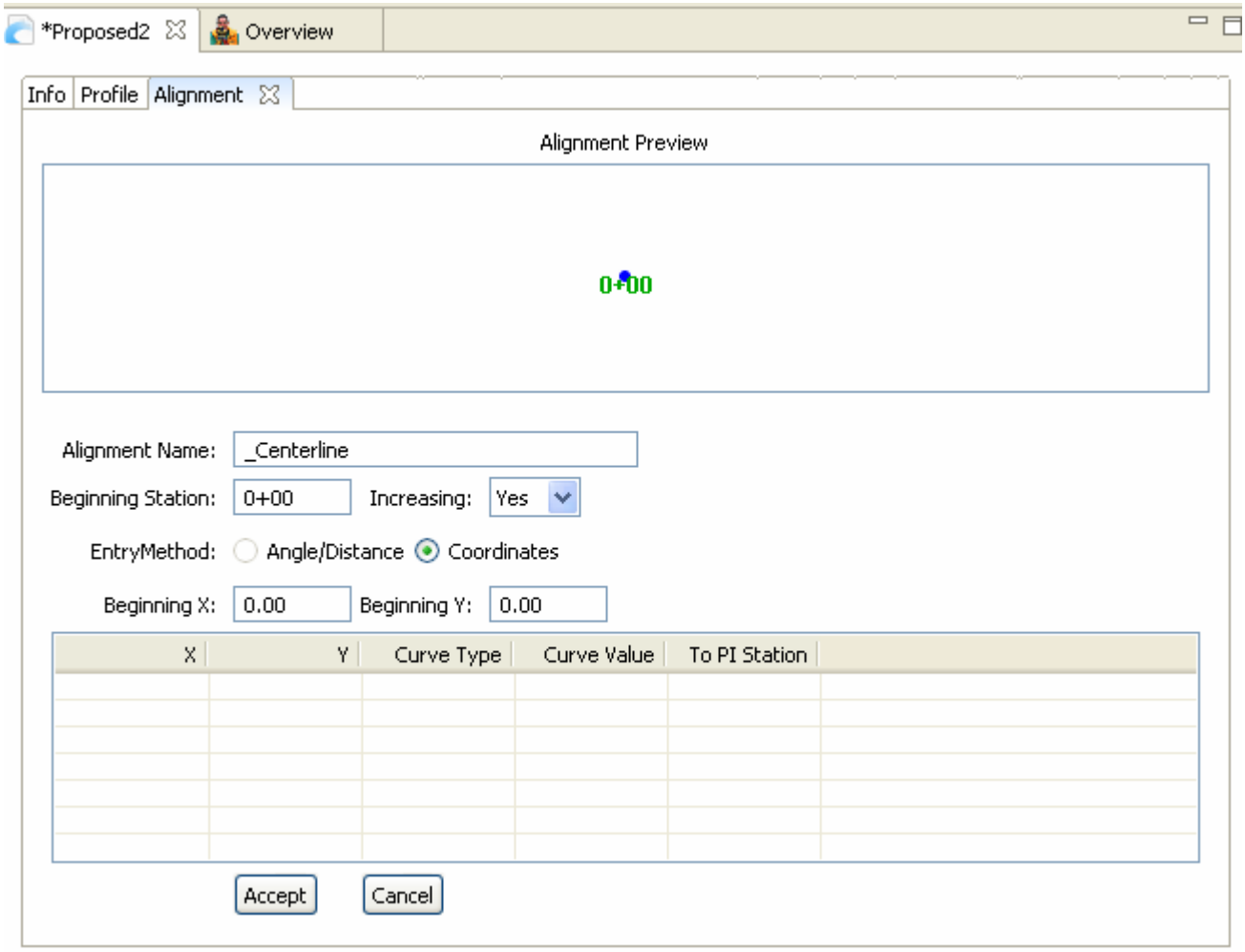
11.2. New Alignment

You have the option of creating a new alignment from within WDT. Selecting this icon will launch a new window which will require you to choose whether to use map graphics or table edit to create your new alignment.



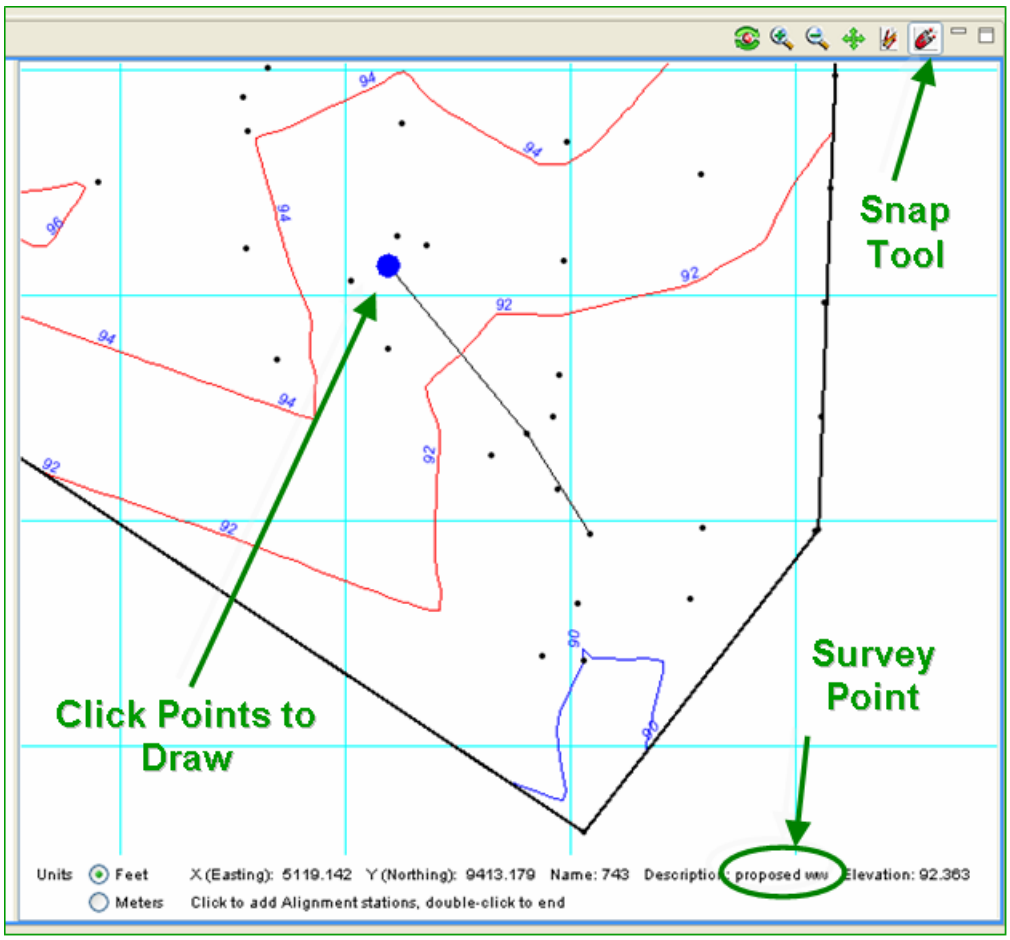
11.2.1. Table Edit

When Table Edit is chosen, the Alignment Editor box and options are the same as the User Defined Alignment option available within the Station Offset Survey Editor Input. See **Station Offset Alignments**.



11.2.2. Map Graphics

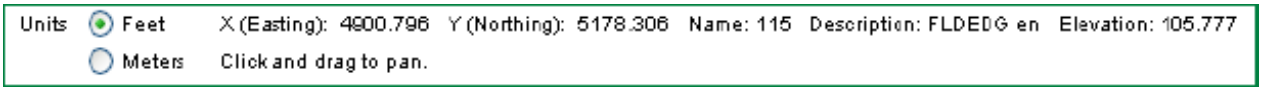
This option allows you to choose the points used for the alignment in the Map Window. You can turn on the Snap to Point Toolbar Button to choose surveyed points as alignment stations. When the snap tool is turned on, survey point descriptions and elevations are displayed which can make entering the alignment easier. Add points to the alignment by clicking new points. Double-click to end the alignment.



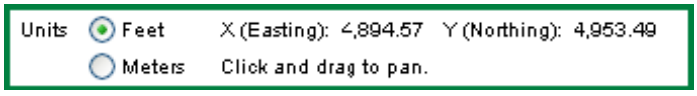
11.2.3. Snap to Point Toolbar Button

This function is toggled on and off by pressing the **Snap to Point** button on the toolbar.

Snap to Point active: When Snap to Point is turned on, a larger blue dot will be displayed on the survey point that is closest to the cursor. The status bar will show the information for the currently highlighted point as shown below:

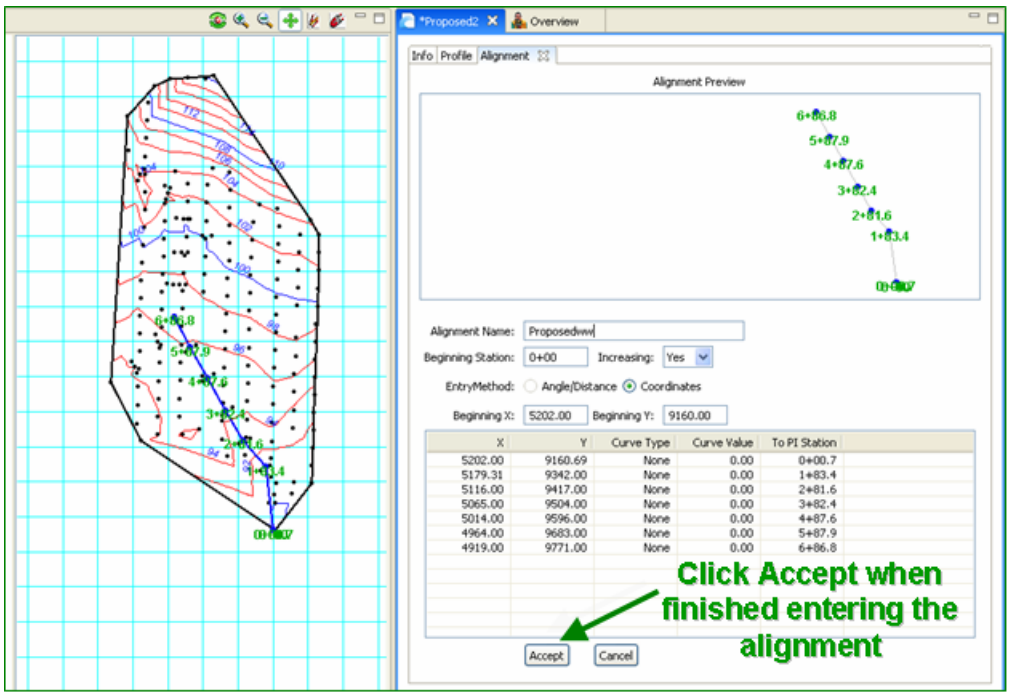


Snap to Point inactive: When Snap to Point is turned off, the cursor moves freely about the survey map. The status bar will show the Northing and Easting coordinates at the location of the cursor as shown in the following example:



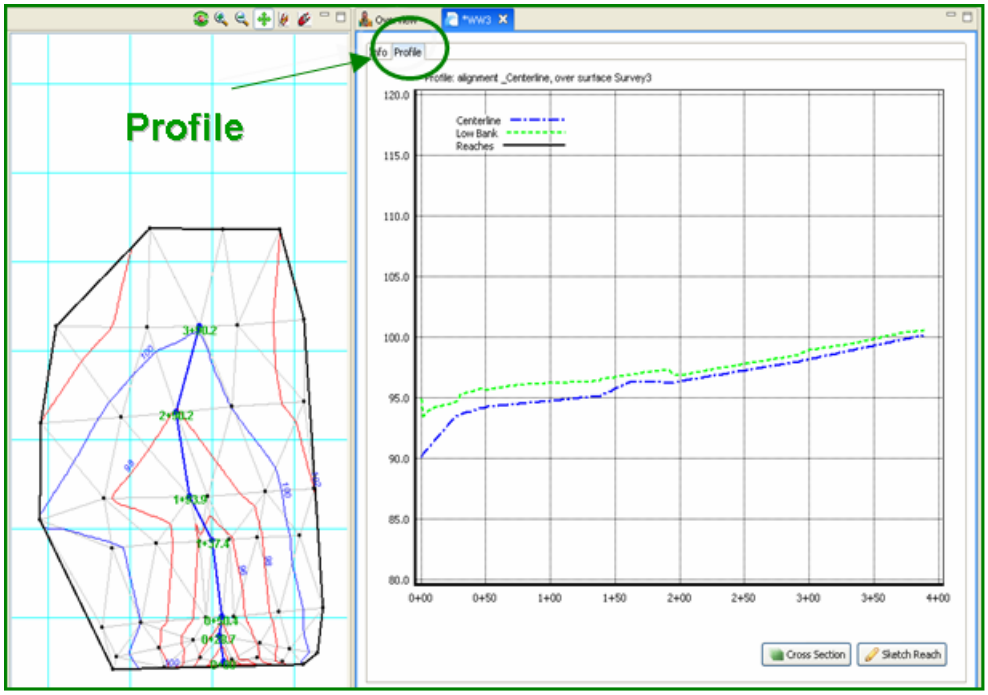
11.3. Edit Alignment

There is also an option to edit the entered alignment. The editor is limited to being able to edit the values in the alignment table. Be sure to click **Accept** button when finished editing the alignment.

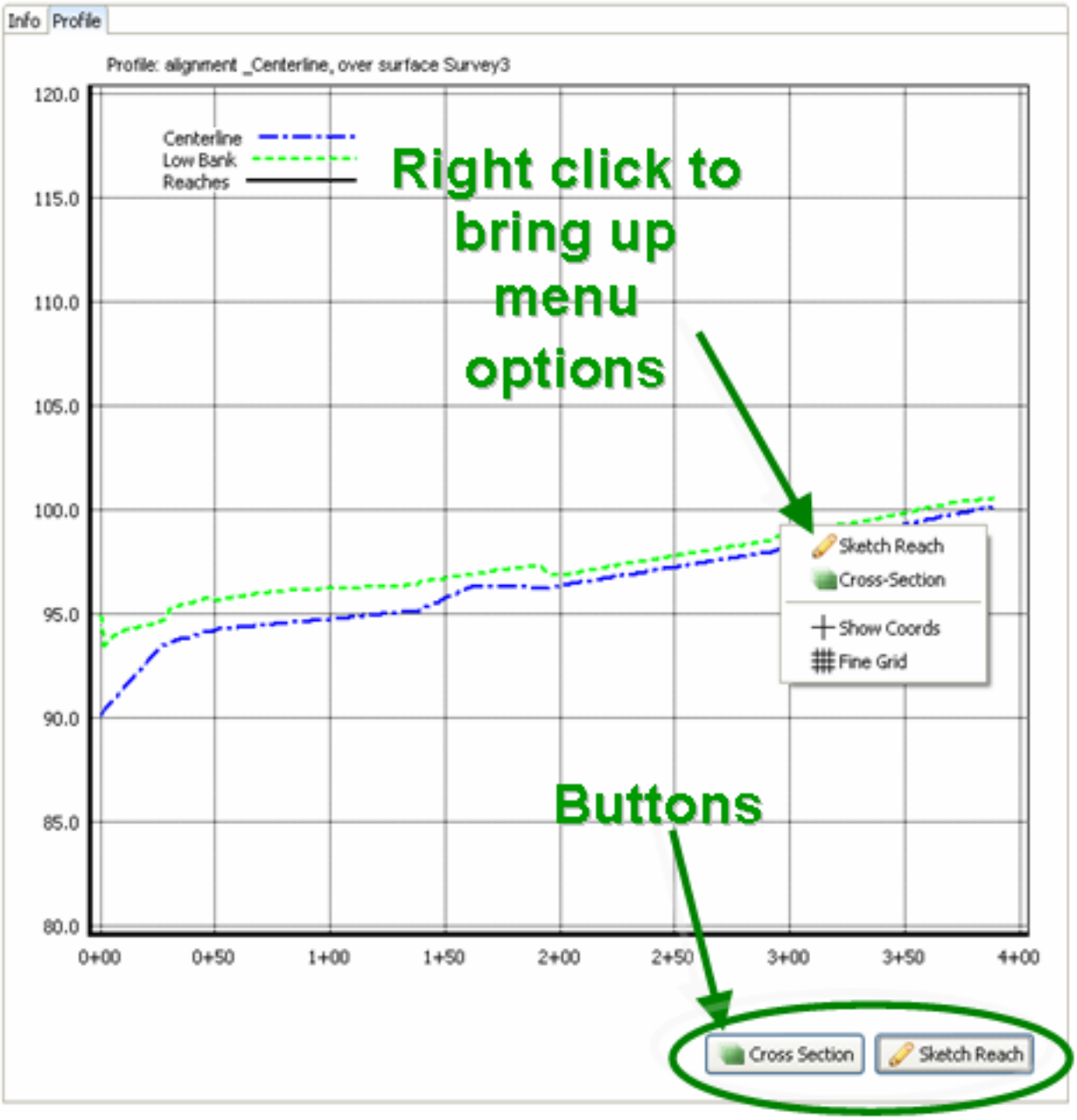


12. Profile and Sketch Reach Tool

Once a survey has been entered and an alignment selected, you can click on the profile tab to view a profile plot of the selected alignment.

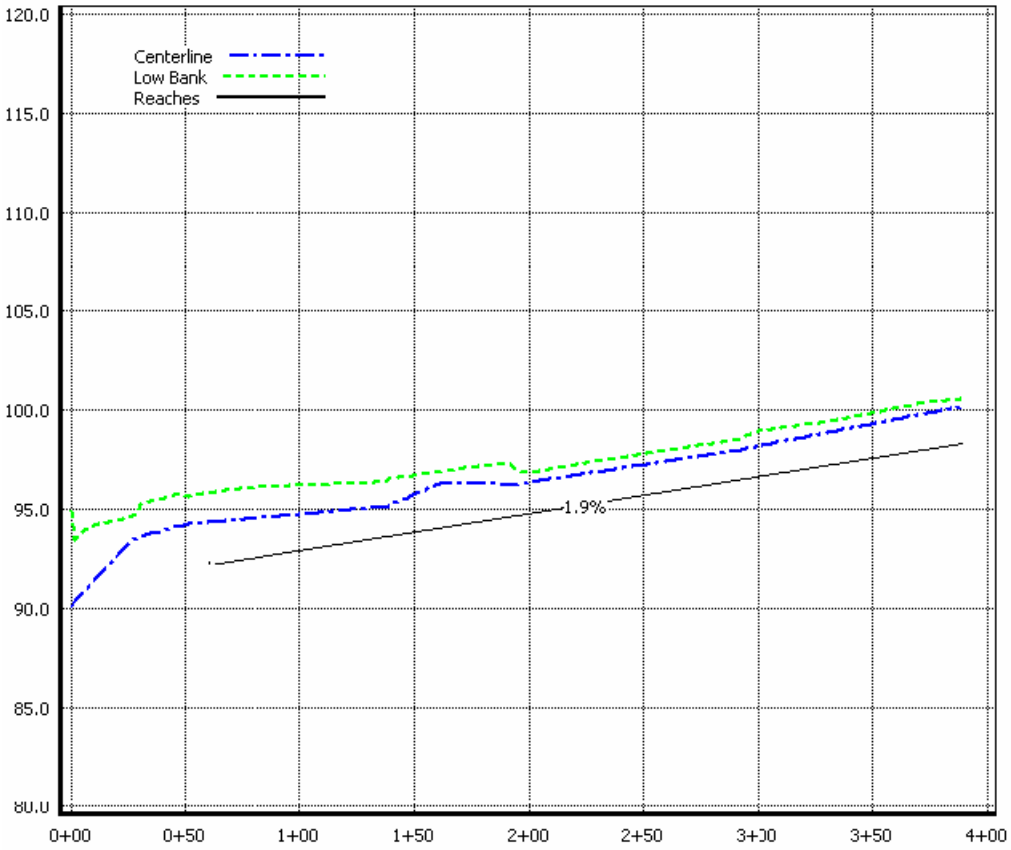


Right click on the profile to bring up an action menu for the profile tab. There are also buttons at the bottom of the profile window.



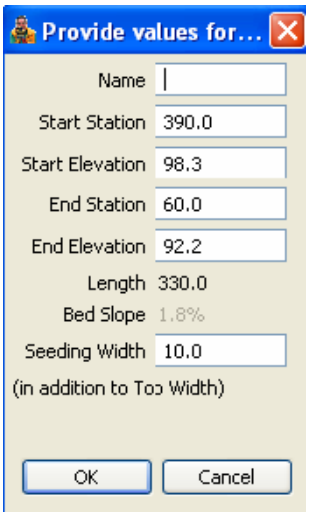
12.1. Sketch Reach

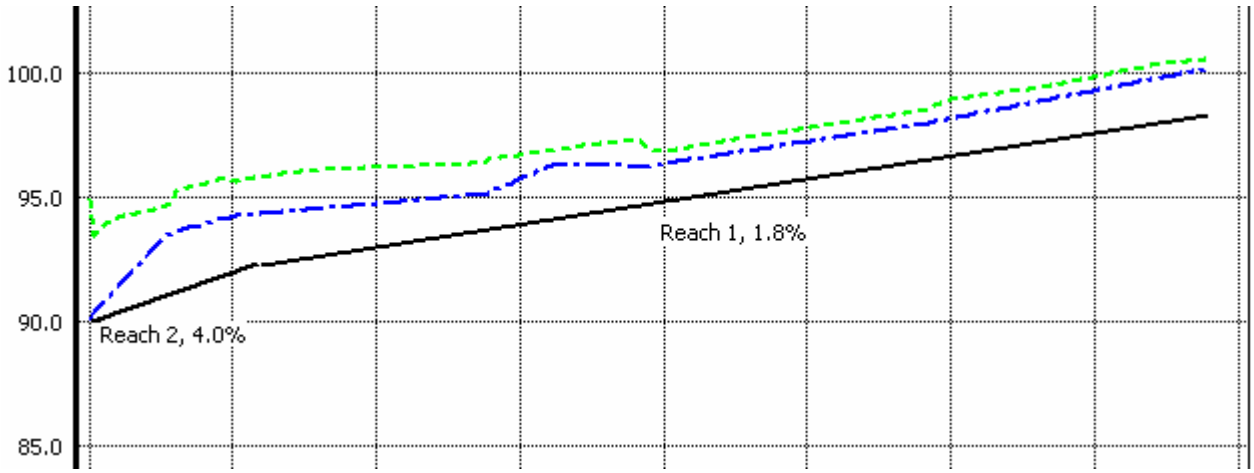
The Sketch Reach tool allows you to draw a reach on the profile which will be used to size the waterway dimensions. The drawn reach profile will be the profile of the waterway bottom. Select the **Sketch Reach** button and then click the starting point for the reach and drag a line to the end point of the reach. The slope of the reach being entered will be displayed as the line is being created.



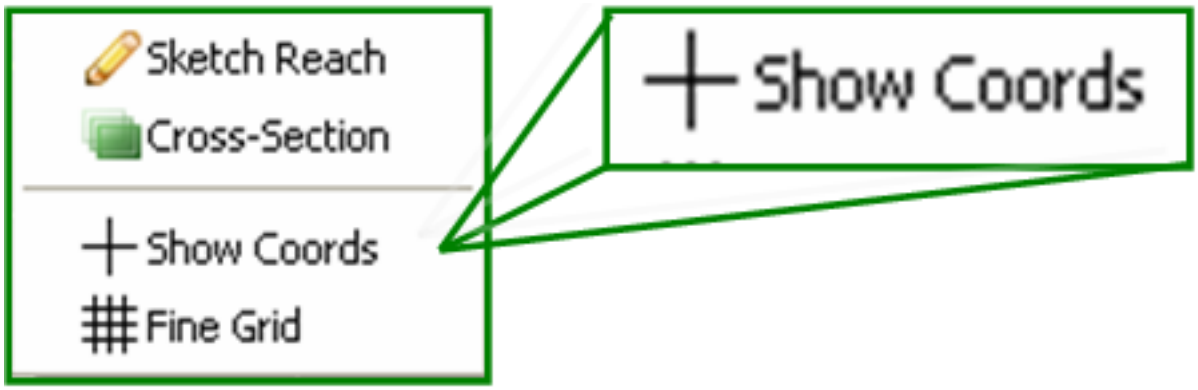
Once the reach has been created, a pop-up box will appear with the dimensions of the sketched reach. You will need to enter a name for the reach. The starting and ending stations and elevations as well as the seeding width can also be modified in this pop-up box. This is helpful if you wish the reach to start and end at a particular station or wants the bottom of the waterway to be at a certain elevation.

Once entered, the profile display will show the reach name and slope below the center of each reach.

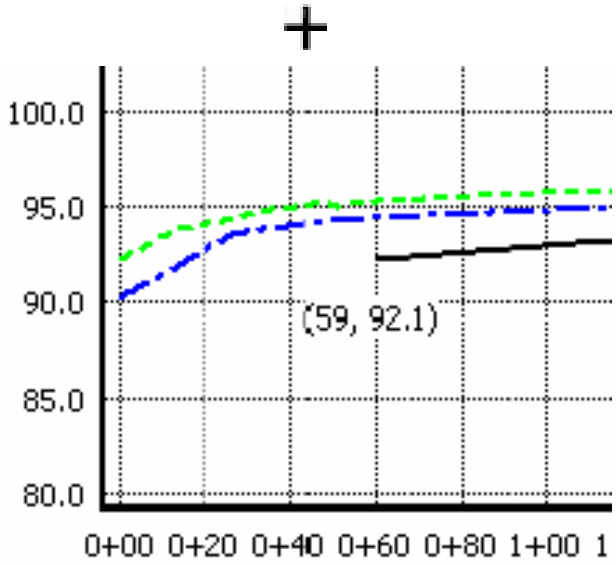




12.2. Show Coords



The Show Coords menu item on the profile right-click menu causes the cursor to display the coordinates of the cursor within the plot window. This can be helpful when sketching a reach. As an example, if you knew the waterway bottom elevation at either end of the reach, you could move the cursor to that position before clicking to start drawing a reach.

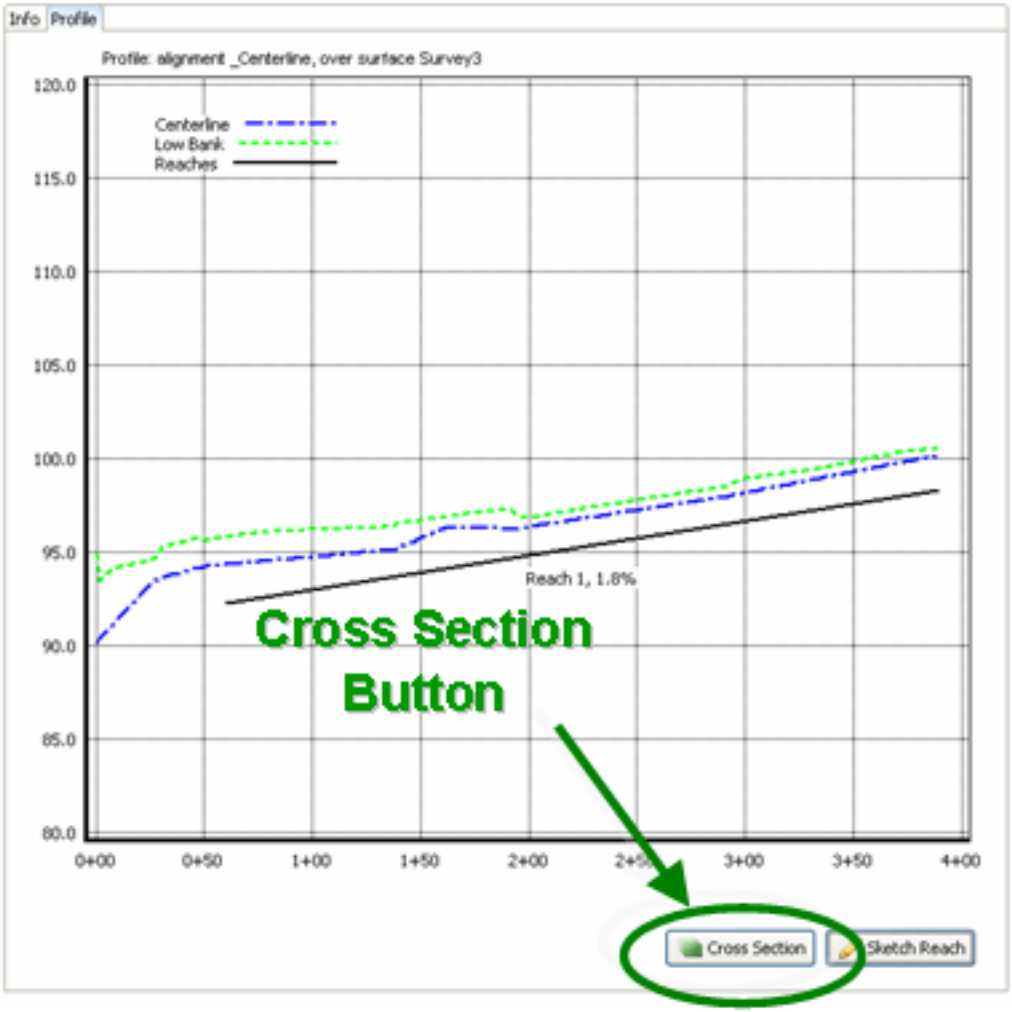


12.3. Fine Grid

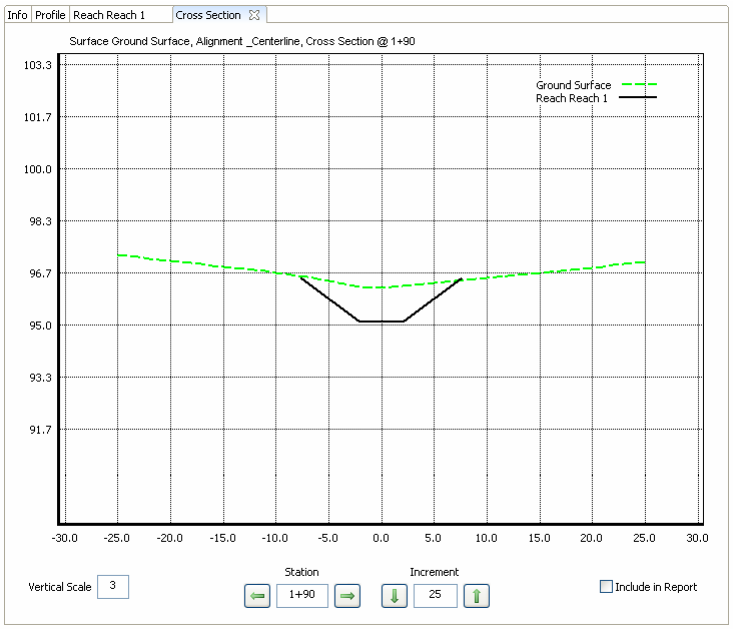
The Find Grid menu item on the profile right-click menu causes the profile plot to display a finer grid divisions of both horizontal and vertical scales.

13. Cross Sections

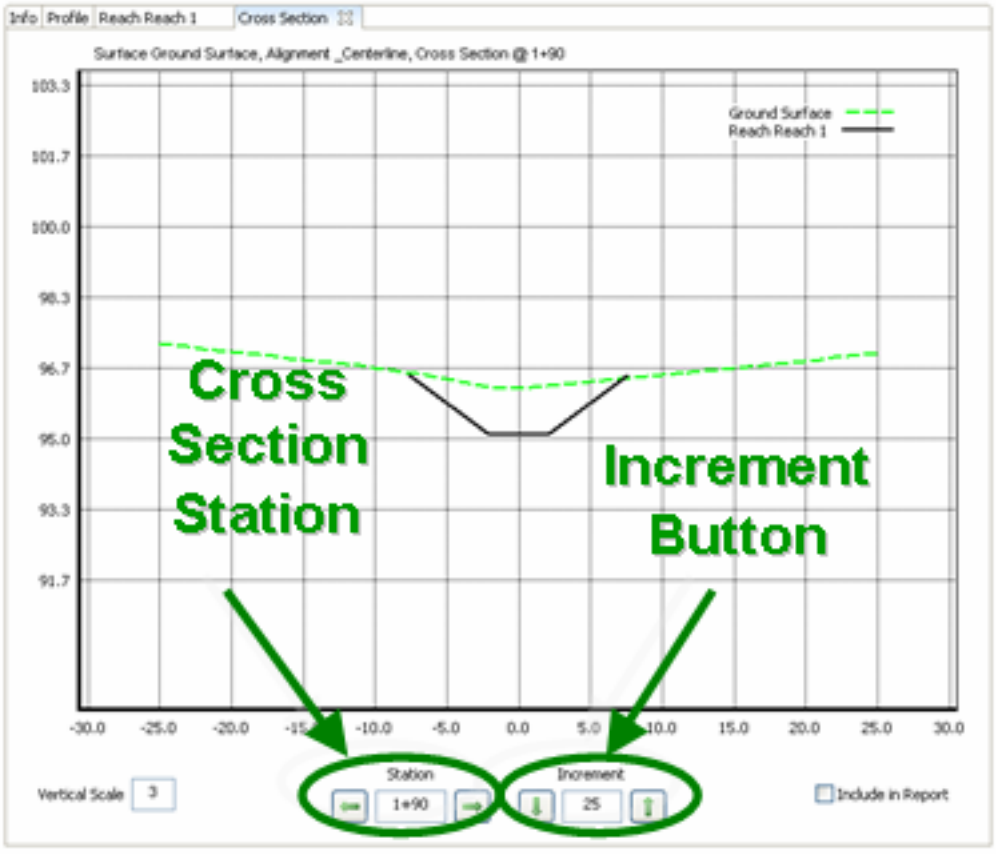
The Cross Section tool is launched by clicking the **Cross Section** button on the profile tab. Then, click on the plot the station you where you would like cross section displayed.



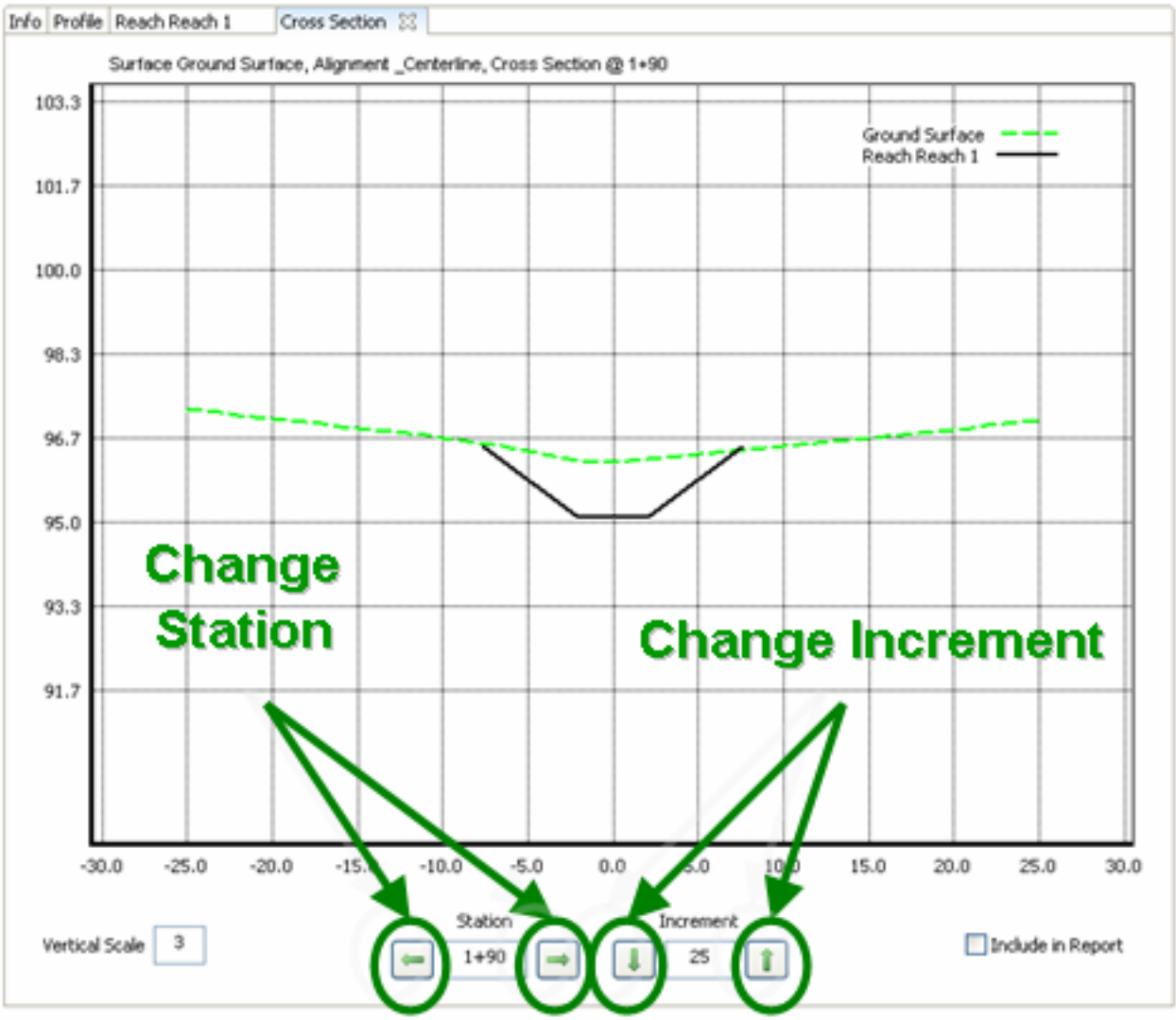
The Cross Section Tab allows you to view a cross section template superimposed on natural ground at the desired waterway station.



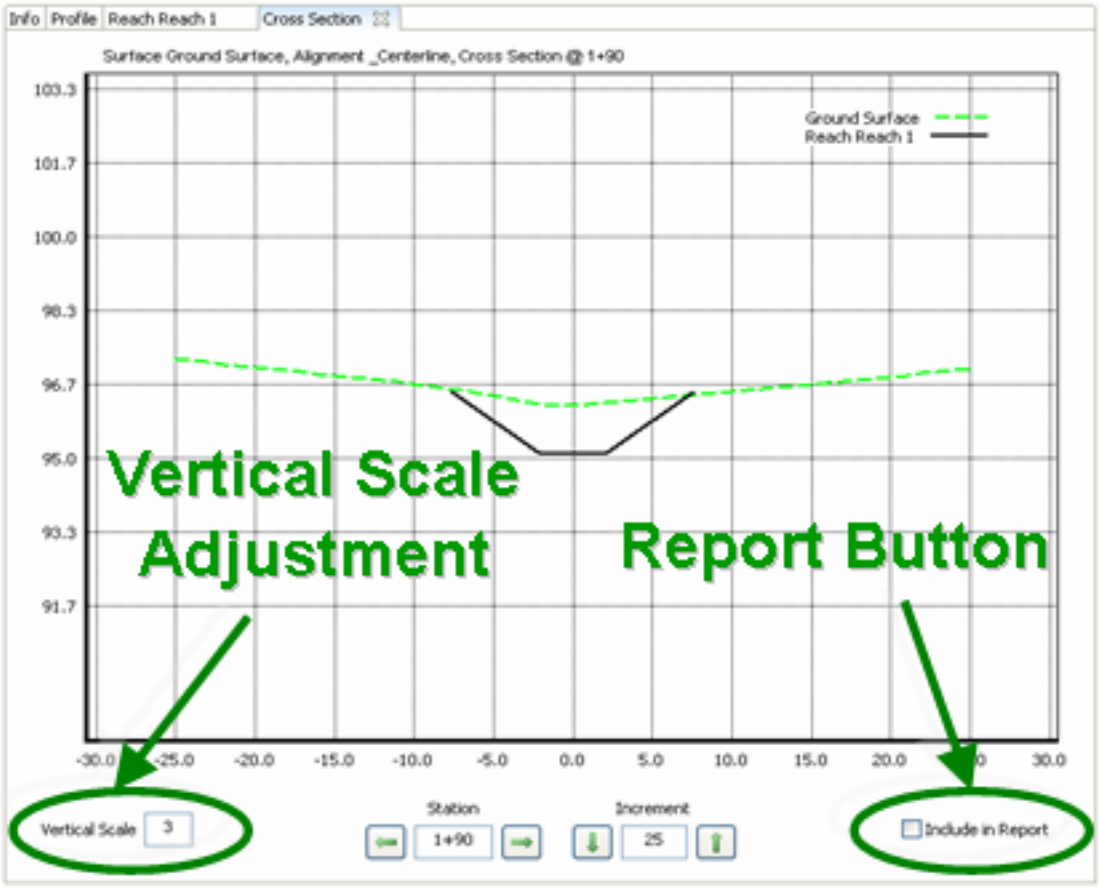
The cross section station is displayed at the bottom of the plot. You can change the cross section by using the arrows to move up or down the waterway by a stationing amount equal to the Increment listed next to the station. You could also just enter the desired station in the station box.



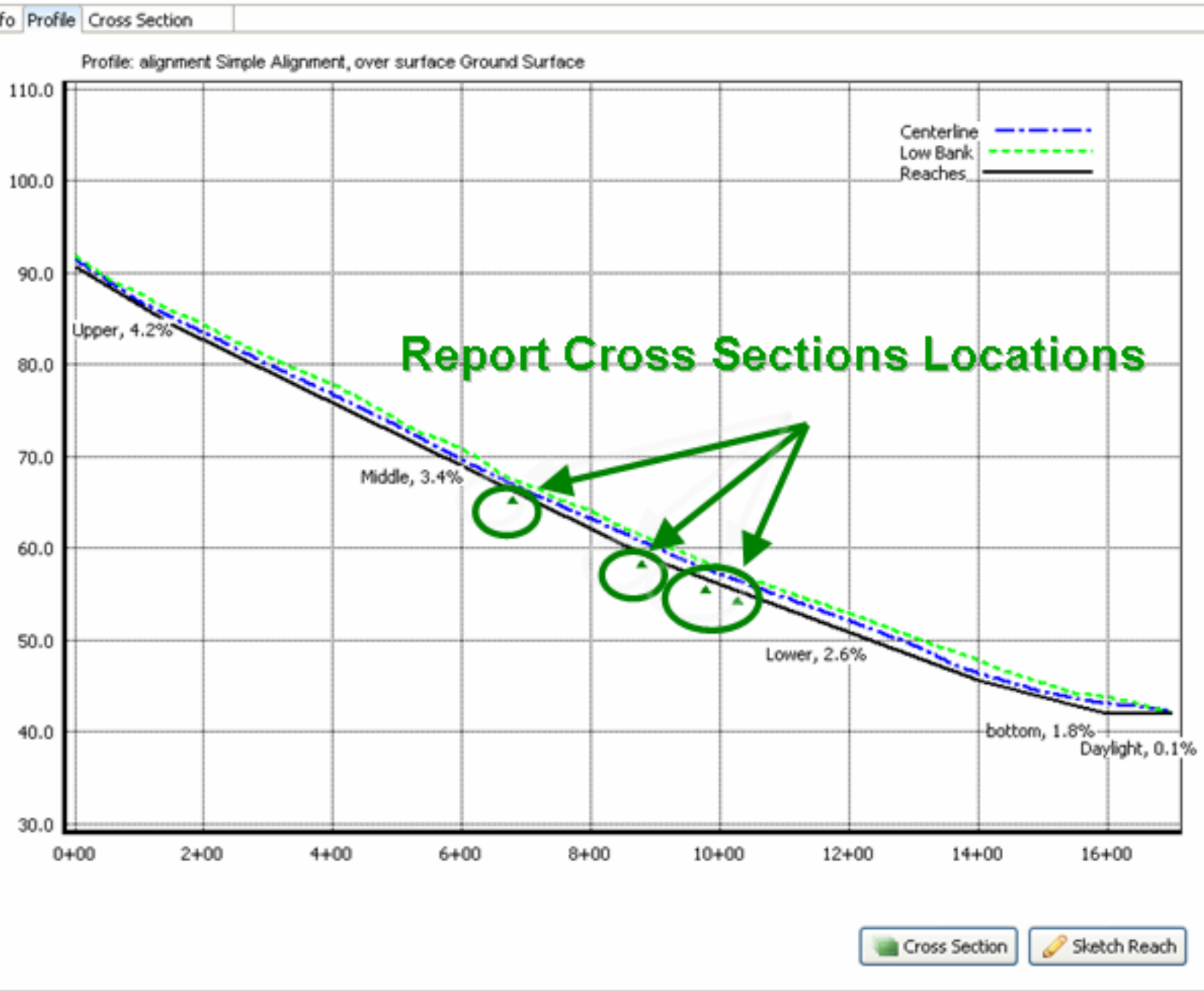
You have the option of clicking on the green arrows to move the station or increment in the desired direction, or you can use the keyboard arrow keys to achieve the same goal.



You can modify the vertical scale of the displayed cross section by entering the desired vertical scale adjustment. Cross sections can also be captured in the report by clicking the Include in Report box.



Cross Sections which have been marked for inclusion in the report will be marked on the waterway profile.



14. Printing

WDT will print to any network printer or plotter, or save the printout to an Adobe pdf file. The program will present a preview of the printout before sending to the printer.

There are four ways to print WDT reports:

1. Print a waterway reach simulation report.

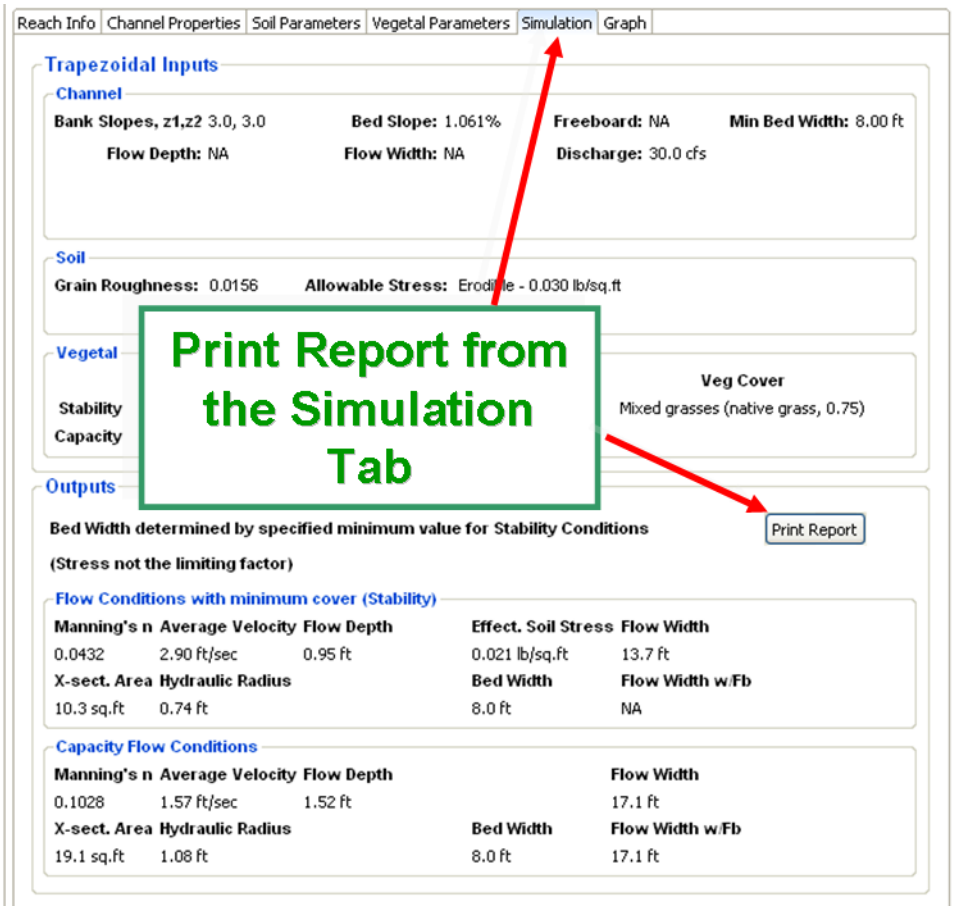
2. Use Print from within an open waterway manager.

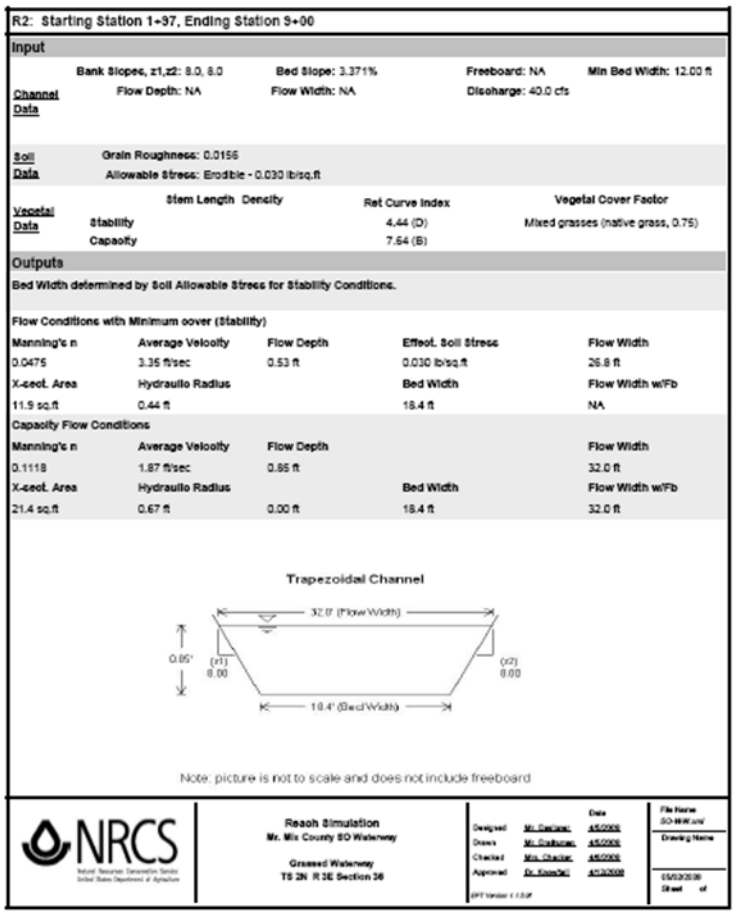
3. Print a Project by selecting a project from the Overview tab (Printing Multiple Waterways or Diversions).

4. Print an single waterway by selecting a waterway manager from the Overview tab.

14.1. Print Report - Waterway Reach Simulation Report

A report which contains a single reach input and output calculations can be directly printed by selecting the Print Reports icon from the Simulation tab. This option only allows you to print the currently selected reach report. A Waterway Reach Simulation Report is a single page report shown below.





R2: Starting Station 1+97, Ending Station 9+00

Input

Channel Data: Bank Slopes, z1,z2: 8.0, 8.0 | Bed Slope: 3.371% | Freeboard: NA | Min Bed Width: 12.00 ft
Flow Depth: NA | Flow Width: NA | Discharge: 40.0 cfs

Soil Data: Grain Roughness: 0.0156
Allowable Stress: Erodible - 0.030 lb/sq.ft

Vegetal Data: Stem Length | Density | Ret Curve Index | Vegetal Cover Factor
Stability: 4.44 (D) | Mixed grasses (native grass, 0.75)
Capacity: 7.64 (B)

Outputs

Bed Width determined by Soil Allowable Stress for Stability Conditions.

Flow Conditions with Minimum cover (Stability)

Manning's n	Average Velocity	Flow Depth	Effect. Soil Stress	Flow Width
0.0475	3.35 ft/sec	0.53 ft	0.030 lb/sq.ft	26.8 ft
X-sect. Area	Hydraulic Radius		Bed Width	Flow Width w/Fb
11.9 sq.ft	0.44 ft		18.4 ft	NA

Capacity Flow Conditions

Manning's n	Average Velocity	Flow Depth		Flow Width
0.1118	1.87 ft/sec	0.85 ft		32.0 ft
X-sect. Area	Hydraulic Radius		Bed Width	Flow Width w/Fb
21.4 sq.ft	0.67 ft	0.00 ft	18.4 ft	32.0 ft

Trapezoidal Channel

Note: picture is not to scale and does not include freeboard

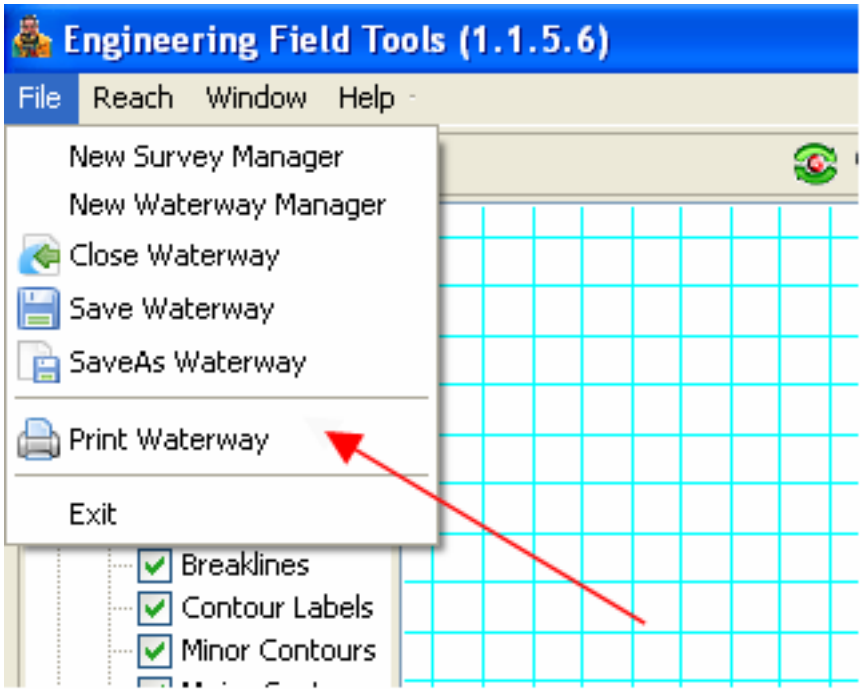
NRCS

Reach Simulation
Mr. Mix County SO Waterway

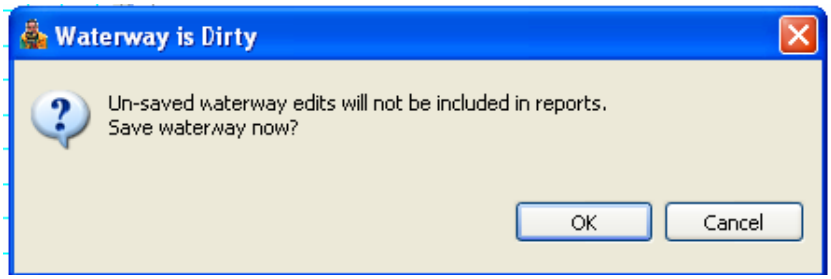
Grassed Waterway
TS 2N R 3E Section 36

14.2. Open Waterway Printing

With the desired waterway manager open and with the waterway manager tab selected, select **Print Waterway** from the drop-down File menu at the top left of the EFT window.



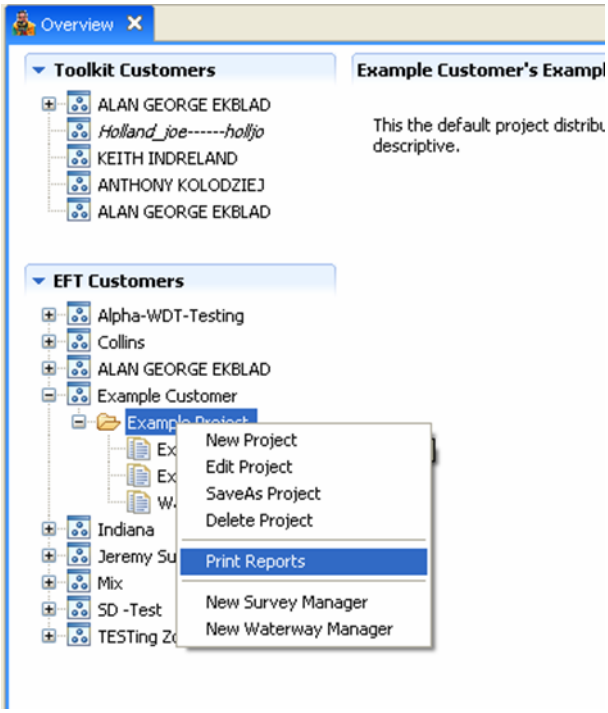
If changes have been made to the waterway since it was opened, the program will prompt you to save the open file before printing. Click on '**OK**' to save the file and continue printing or '**Cancel**' to return to the waterway manager.



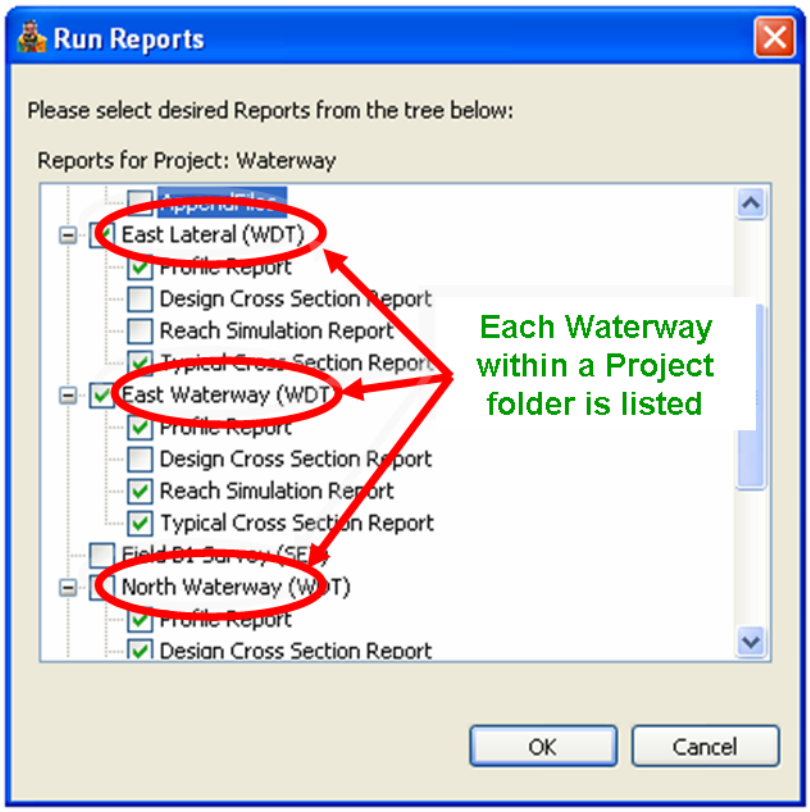
You will then be prompted to select the reports to be printed. You will select reports from the Report Tree.

14.3. Printing Multiple Waterways or Diversions

The WDT software can print multiple waterways or diversions as long as the desired waterway or diversion files are within the same project folder. From the Overview window select a project which contains the waterway or diversion files to be printed. Right click on the project name and select Print Reports.



Once you have clicked on Print Reports, the program will open a Report Tree which has options to print each manager file within the project folder. You can designate which report to print for each individual waterway or diversion. Each different manager has either (SET) or (WDT) behind the manager name to designate whether the manager is a Waterway Design Tool or a Survey Engineering Tool.



14.4. Printing Configuration

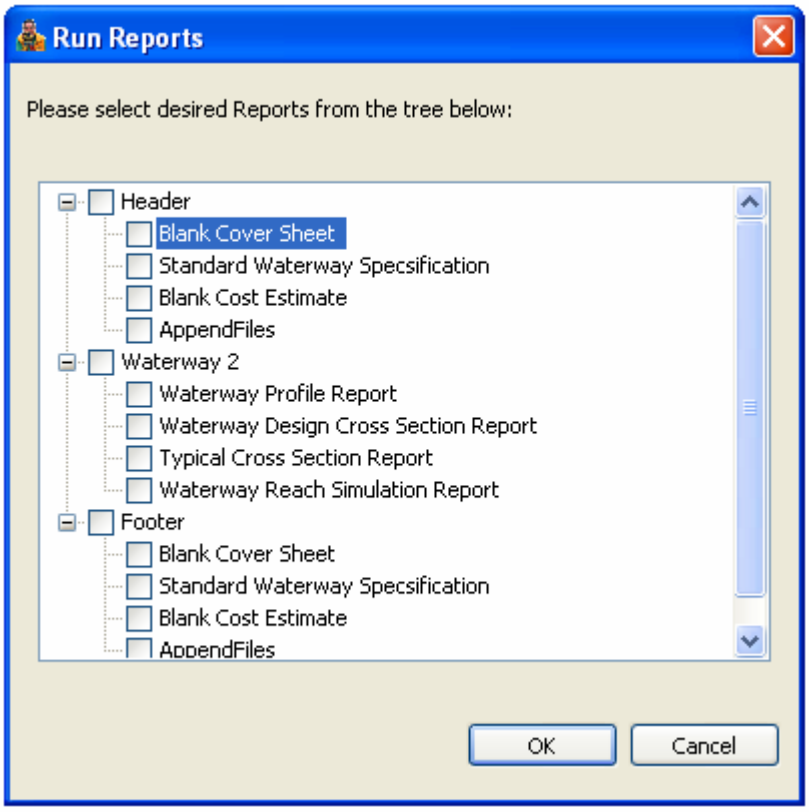
The user chooses from a selection of WDT generated reports and user added reports consisting of pdf and image files. The user will select which reports will be added to the final report by clicking the appropriate box for each desired report section on the Report Tree.

The print configuration is saved by WDT so that the next time the user chooses to print a specific waterway manager, WDT will remember the reports selected for printing and will remember the configuration of those reports. If you want to change the configuration of a report, you will have to un-check that report and then select that report again. An example would be if you want to change the selected cross sections for the Design Cross Section Report, you would have to un-check the box for the Design Cross Section report and then re-check the box to select this report. Once this has been done the user can reconfigure the report selections.

14.4.1. Report Tree

There are multiple sections to the Report Tree. The **Header** and **Footer** sections contain optional default pdfs that have been added as a part of user preferences and optional **AppendFiles** that are pdfs or image files that are added only for this particular report. You add sheets to the report by selecting either the box next to each desired sheet or selects the box for each section to include every sheet within each section.

If you are printing an entire project, there will be a section for each waterway manager within the project. In this way, multiple waterways within a field or multiple branches of the same waterway can be printed together as one project. The name of each waterway manager is used to name each section for printing.

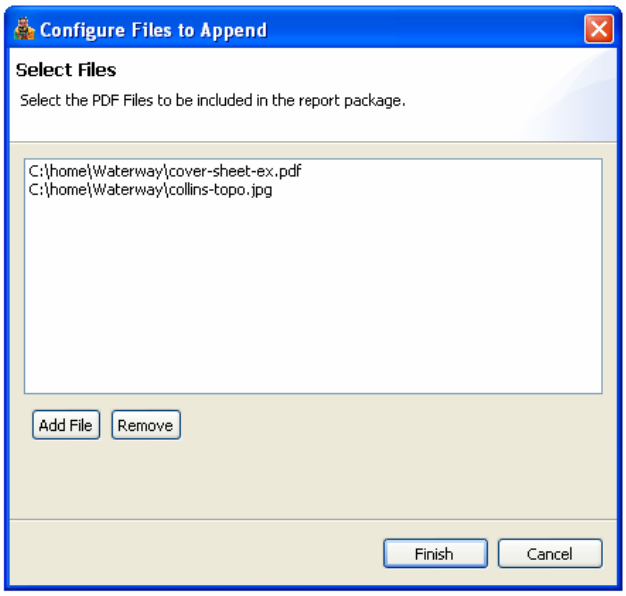


14.4.1.1. Header/Footer - Defined Preference Report Pages

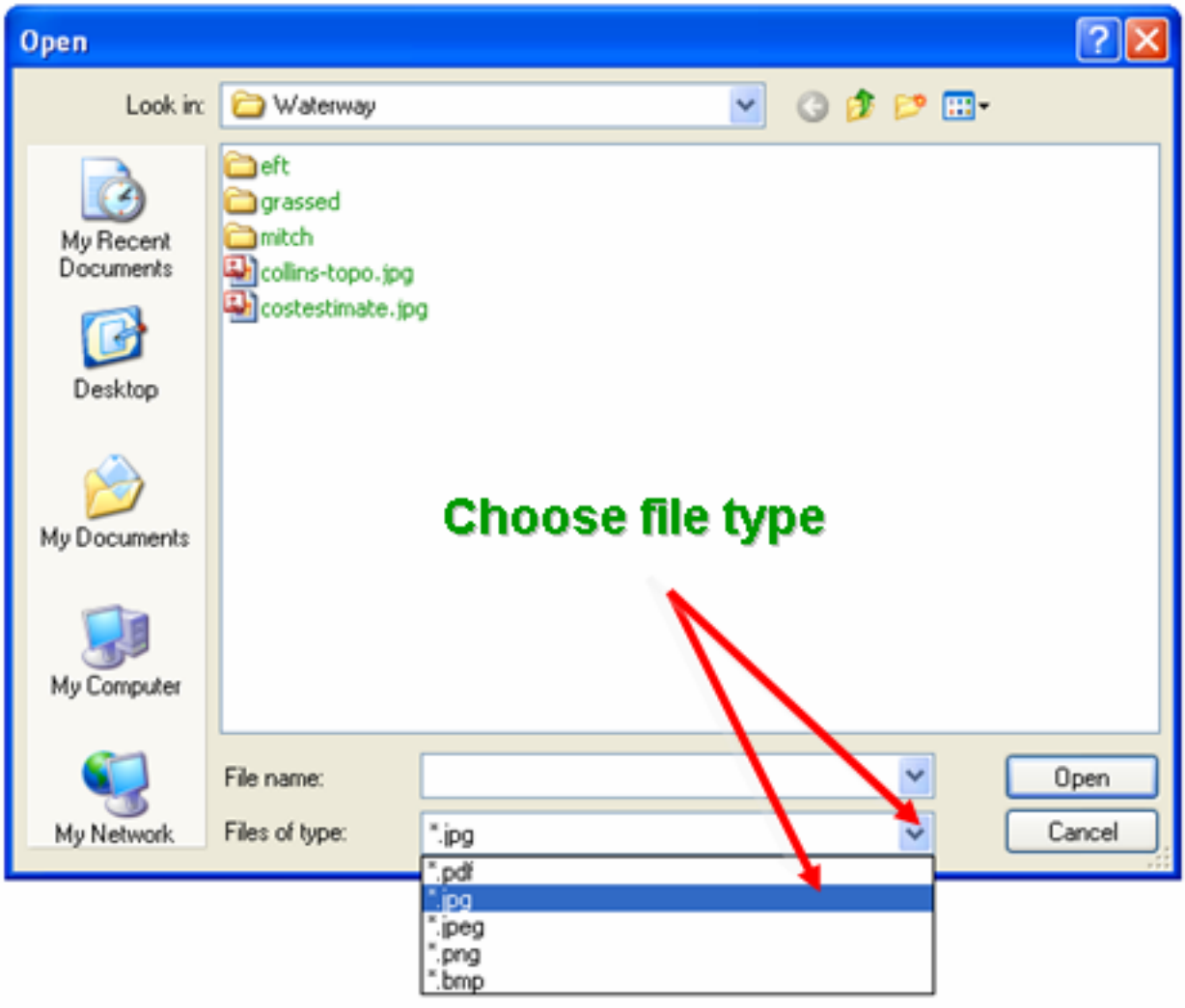
Within WDT, you can define several standard report pages that would be made available every time you print a report within WDT. The process for selecting these default user defined report pages is described in the **Preferences** section of this user's guide. Standard report pages might include a blank cover sheet, a standard state waterway specifications sheet, a blank cost estimate sheet, a standard detail such as a rock check, etc. Once these pages have been defined, they are available for selection each time a report is generated. To include these pages in the report, you select the box next to the name of the standard report to be included. Standard report pages can be one page or multiple pages. These standard reports can only be added as pdf files. The report generator will add a page number to these pages, but that is the only information added.

14.4.1.2. Header/Footer - AppendFiles

AppendFiles allows you to select pdf or image files which will be printed with the current report. These files are not saved for future printing and must be selected each time they are to be added to a report. This allows you to add output which would be specific to a waterway. Examples would be a cover sheet which has an image added specific to the planned waterway, a cost sheet which has been itemized for a specific job, plan view sketch, etc. Once you select the AppendFiles option, a pop-up box will allow you to select the desired files to append to the report.



Click on **Add File** to select files to append to the report. To use image files, change the file type in the Open pop-up window.

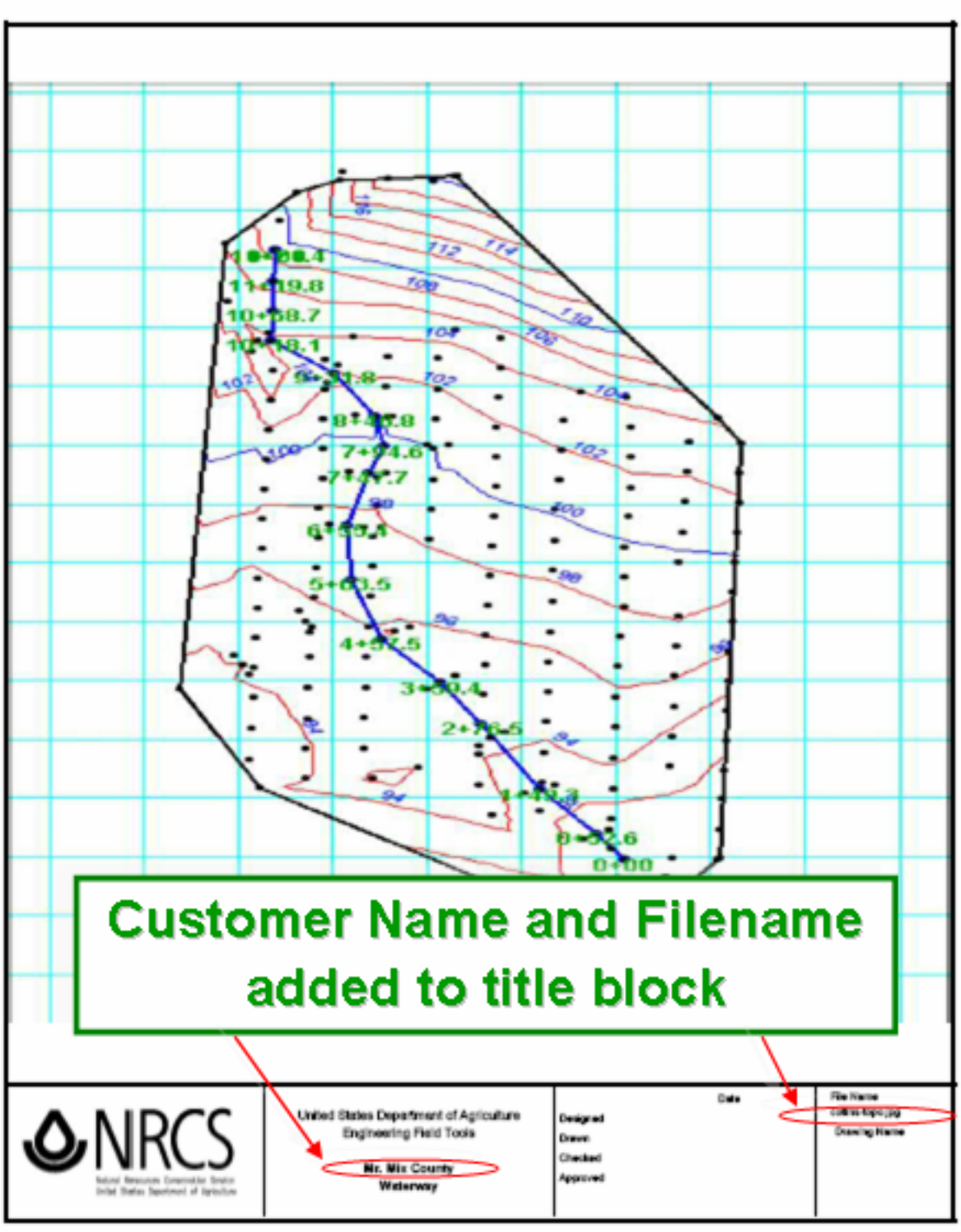


14.4.1.2.1. Pdf files

Pdf files can contain more than one page and will be incorporated into the output report on an as-is basis. Page numbering will be the only addition to the page added.

14.4.1.2.2. Image files

Allowable file types include : jpg, jpeg, png, and bmp. Image files will be imported and resized to fit within a title block page.



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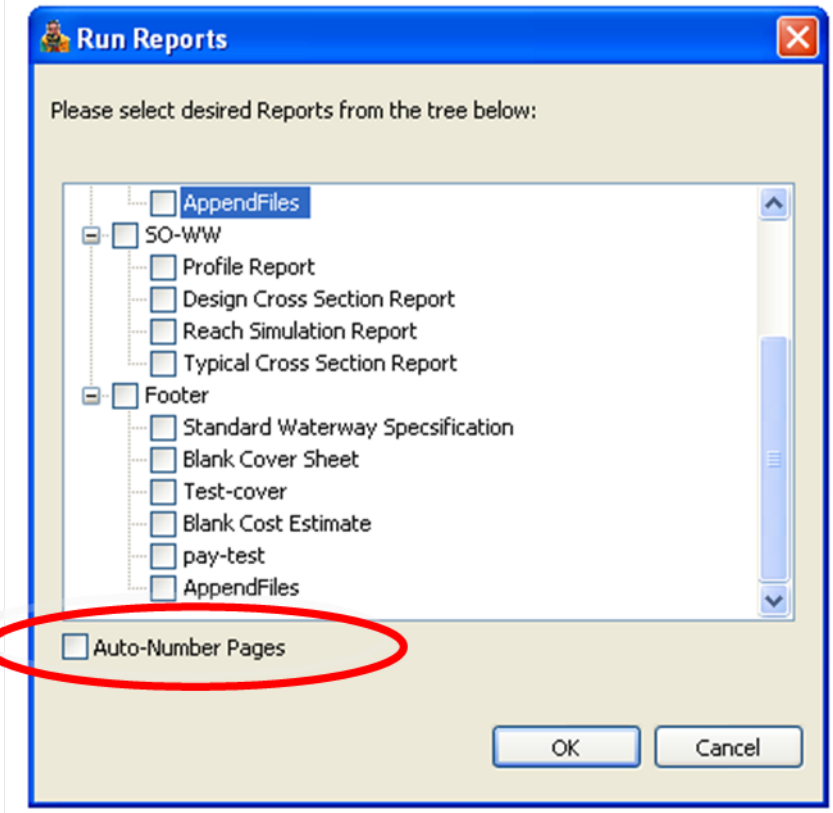
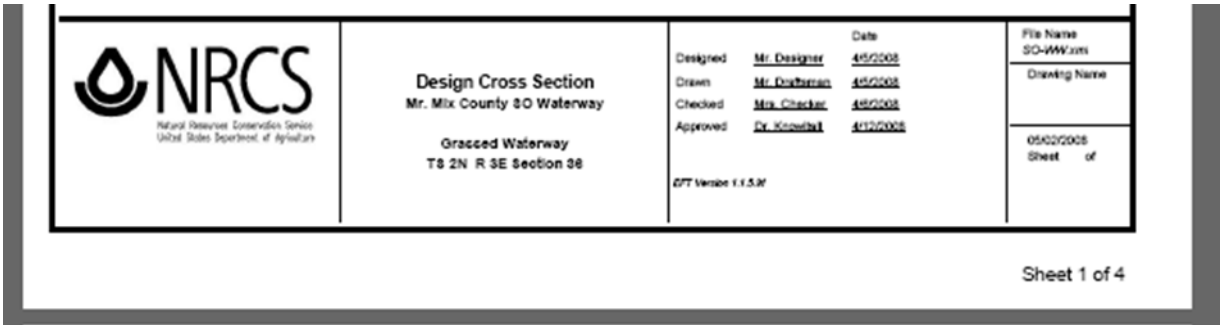
14.4.1.3. Report Page Numbering

Within WDT, you can choose to have page numbering added to every report page or to have this auto-numbering turned off. Select the check box for auto-numbering pages if you want page numbers on every report page. Unfortunately, page numbers are not placed in the title box. Software limitation for the report generation software can not place the page number within the title box for every selected page size. For this reason, if selected, page numbers are printed outside the title box.





14.4.2. Waterway Manager Print Section

Each waterway manager section is labeled with the name of the waterway manager to be printed. Each of these sections has four different report sheet types to choose from. You can print all sheets by checking the box for the section or can choose which sheets will be added to the overall report.

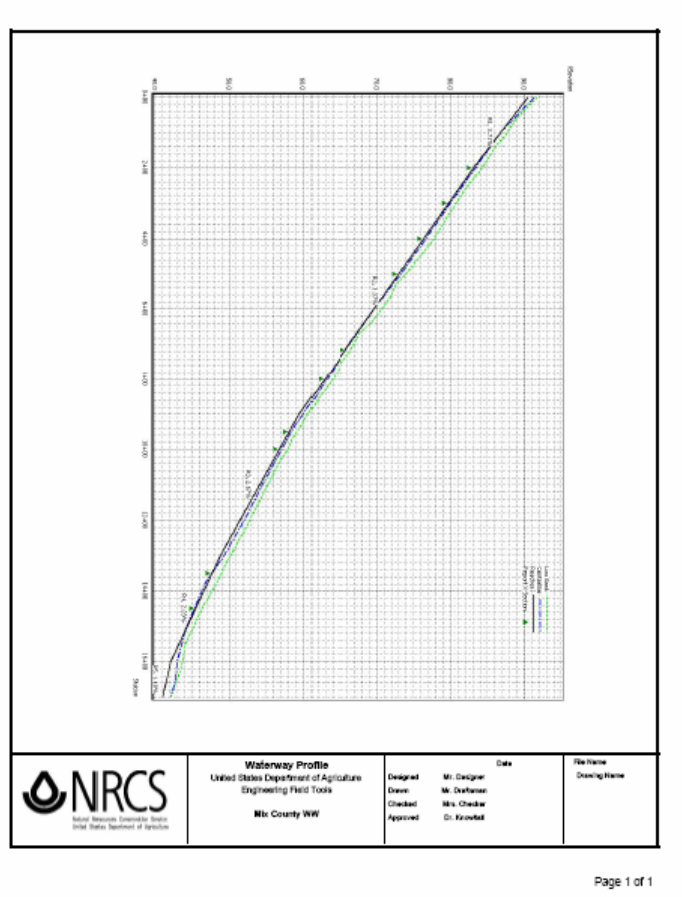
14.4.2.1. Waterway Profile Report

A waterway profile report prints the waterway profile with a title block. The displayed profile will be the same as what is displayed on the Profile tab.

Note

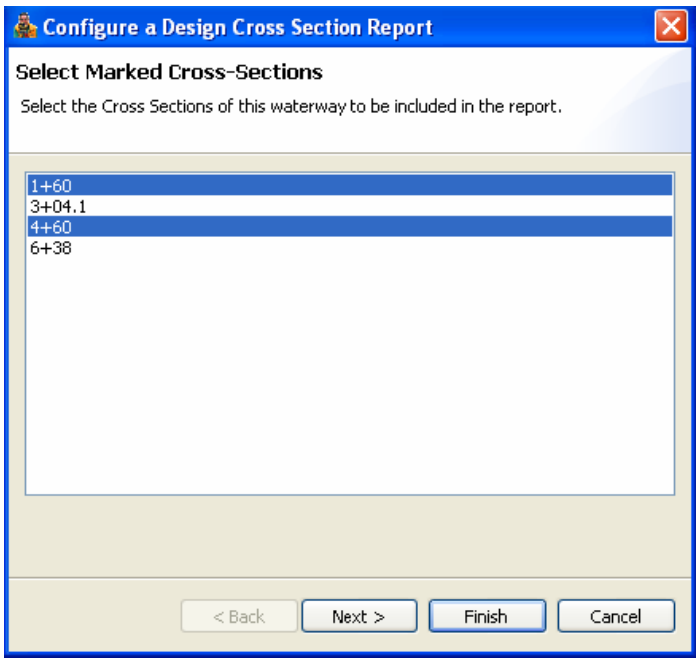
Users may want to consider breaking long waterways into multiple waterway manager files. This will allow for better resolution in viewing the profile. This can be done by making copies of the completed

long waterway manager (click on the **File** menu item and then click on the **Saveas Waterway** option) and deleting reaches from the manager copies.

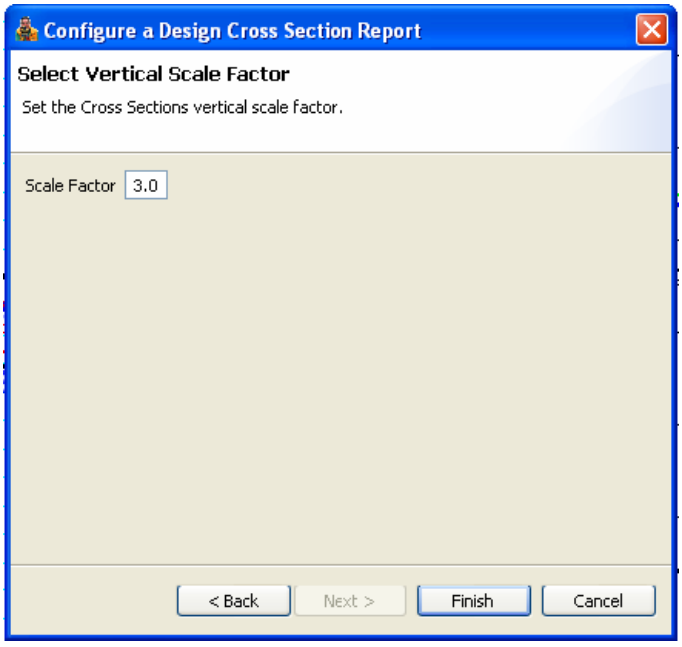


14.4.2.2. Waterway Design Cross Section Report

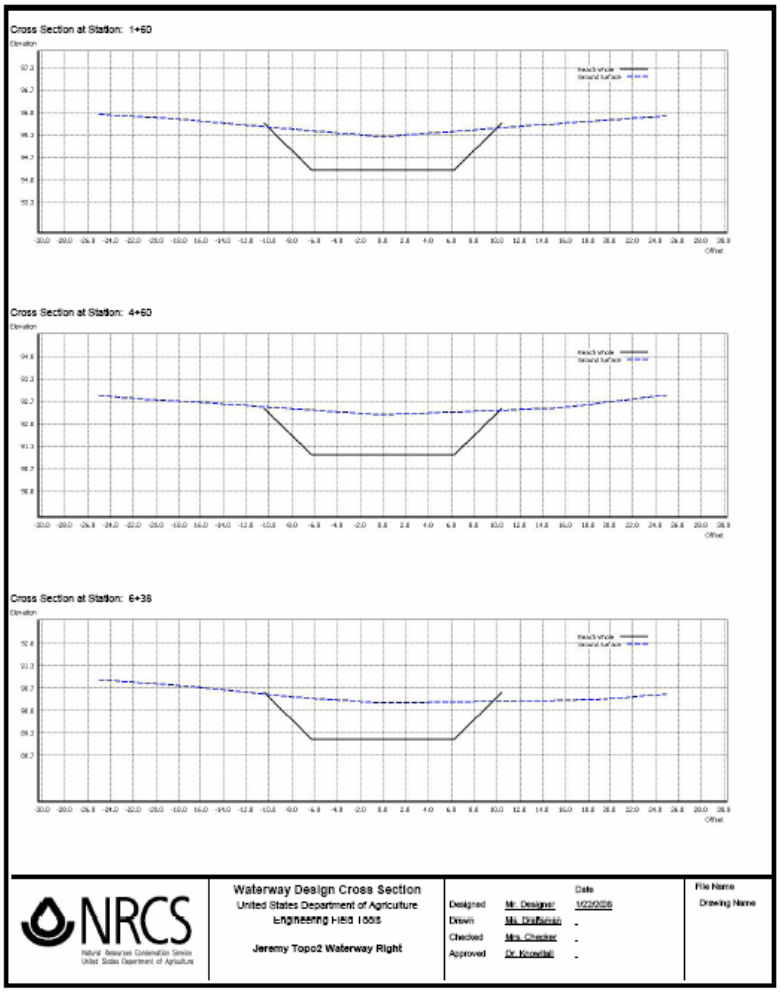
The Waterway Design Cross Section Report generates report pages which contain design cross section examples. Up to three cross sections will be printed per page. Once this option has been selected, you are prompted to choose from a list of cross sections to print. The cross sections available to print will be the cross sections which have had the **Include in Report** box checked on the **Cross Section** tab. Selected cross sections to be printed are shown as highlighted. Cross sections can be added or removed from the list by holding the **Ctrl** key and clicking on the desired cross sections.



Once cross sections have been selected, you can select **Next** to define the Vertical Scale Factor for printing or can select **Finish** to print the cross sections with a default vertical scale factor of 1. The vertical scale factor acts just as it does on the Cross Section tab. If the vertical scale is set too high, the cross section will not plot correctly in the alloted space. If this happens, unselect Waterway Design Cross Section Report in the Report Tree. Then re-check the report to reset the configuration of the Cross Section Report. This will let you change the vertical scale to a lower value so it will plot correctly.



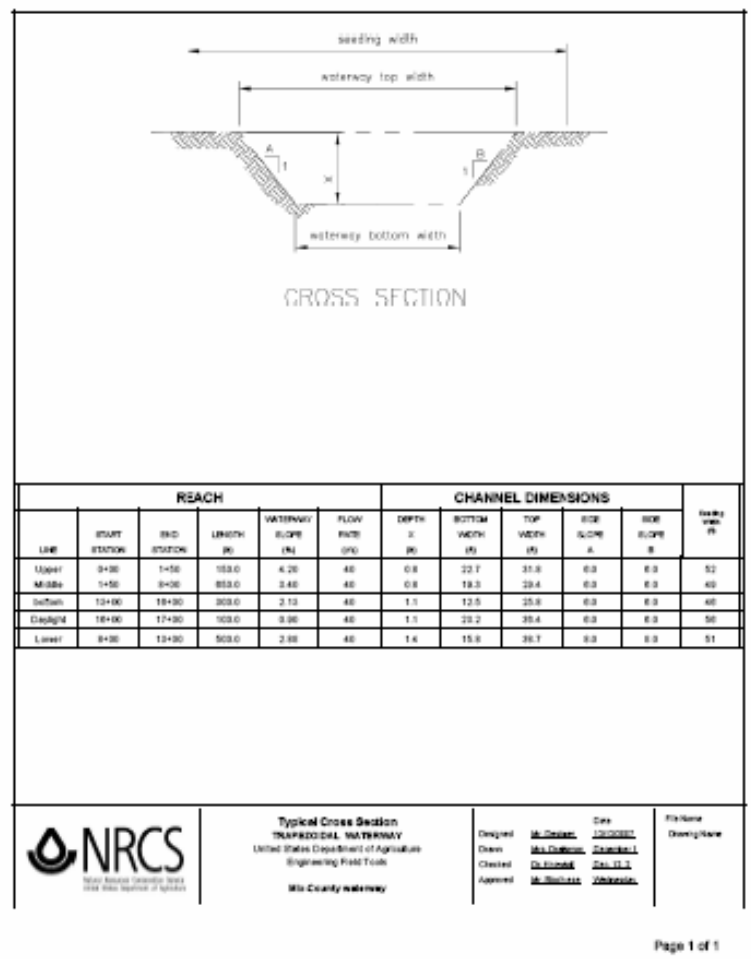
Below is an example of the generated cross section report.



Page 1 of 1

14.4.2.3. Typical Cross Section Report

The Typical Cross Section Report provides typical waterway dimensions for each waterway reach section. A separate page will be produced for each different one channel type that exists for the different reaches being printed. All reaches within a waterway manager will be printed when this report is selected.

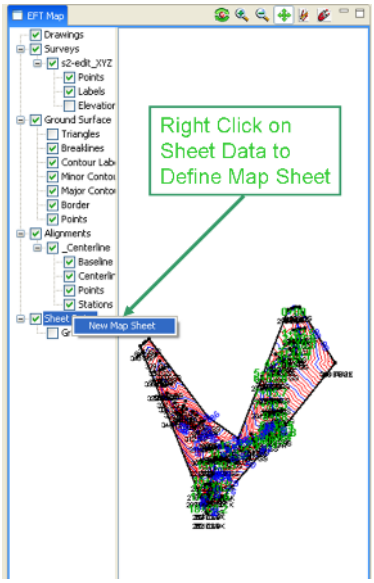


14.4.2.4. Waterway Reach Simulation Report

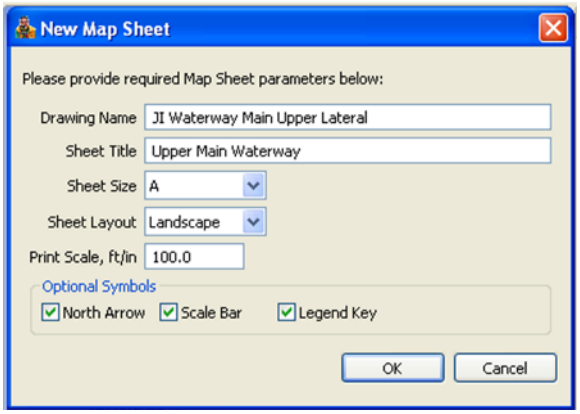
When this option is selected as part of the Report Tree, you will be prompted to select which reach reports to print. These reports have already been described in the Print Reports – Waterway Reach Simulation Report section. You will select which reaches will be added to the report in the same manner that cross sections are added to the cross section report. Once selected, a page will be developed for each reach selected.

14.4.2.5. Map Sheet Report

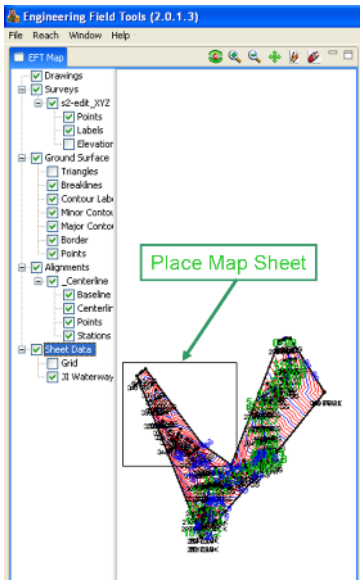
The Map Sheet Report provides a printed views from the EFT Map Window. A separate page will be available for print for each different map sheet that has been created. Create Map Sheet by *right click* on the **Sheet Data** legend entry in the EFT Map Window and select **New Map Sheet**.



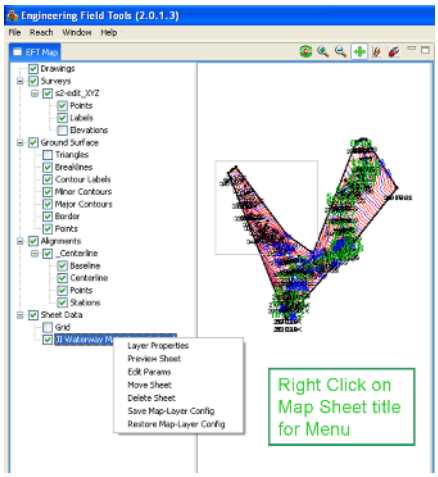
Enter the Drawing Name and Sheet Title for the new Map Sheet. These values will be used in the title block of the Map Sheet Report. The size of the sheet, layout, print scale and optional symbols can also be changed by the user.



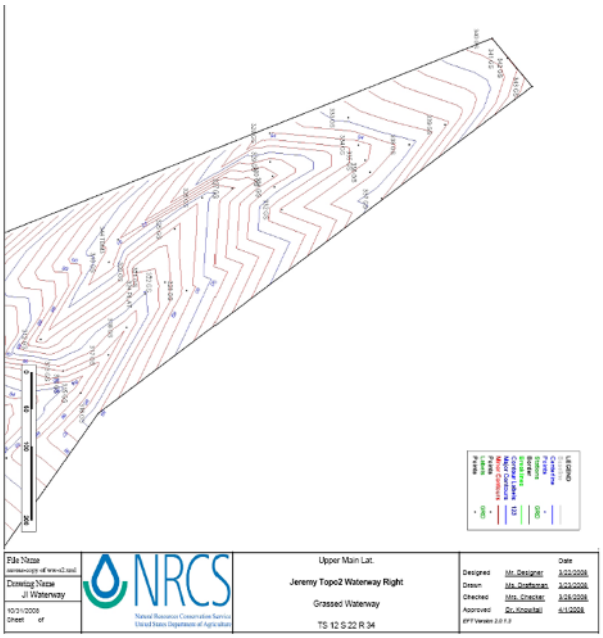
Once this information has been entered, the user will need to place the map sheet definition box where desired for the Map Sheet Report. You may need to Zoom In or Zoom Out to be able to see the entire extent of the defined print box. Changing the Print Scale and the Sheet Size dimensions will change the size of the print area and thus the size of the defined print box.



The user can edit the Map Sheet by Right Clicking on the Map Sheet Title in the legend of the EFT Map Window. This will bring up a list of menu options which will allow the user to edit the initially defined parameters, move or delete the map sheet, preview the map sheet, and save or restore the map sheet settings.



Once a Map Sheet has been defined, it will be available for inclusion when printing. When Map Sheet Report is selected, you will be directed to select the title(s) of the map sheets to include in the report.

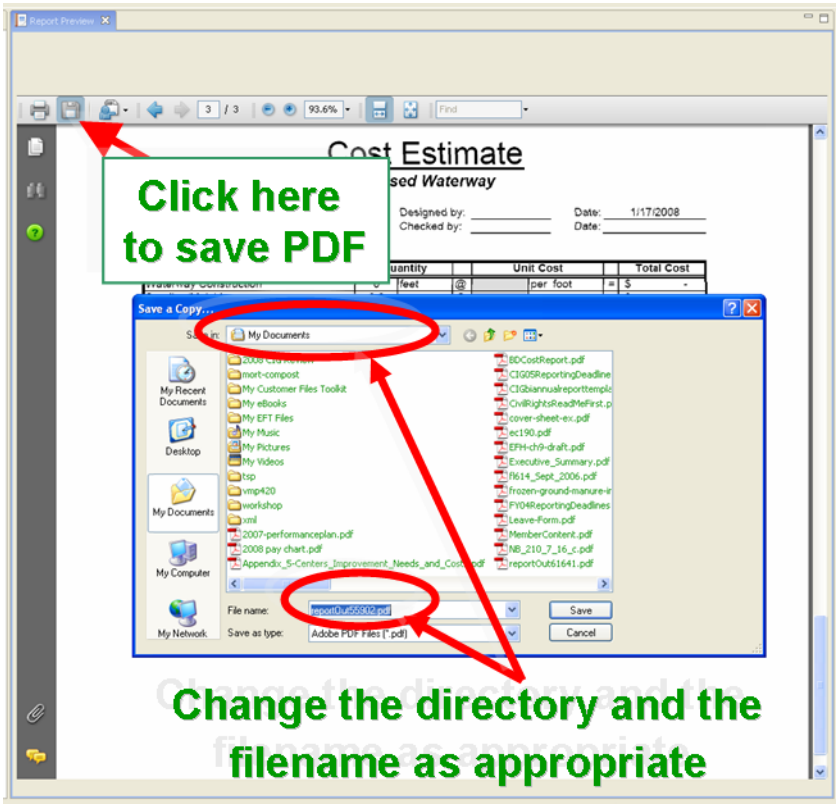


14.5. Title Block

Note that the information entered in the Project Info tab of the Waterway Manager appears in the title block of the printed output.

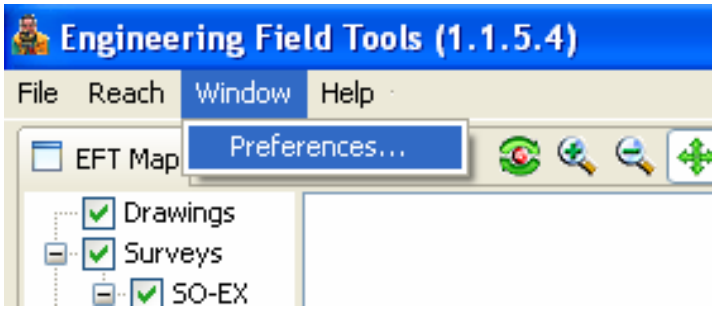
14.6. Saving Printout Pdf

Once the Report Preview is open, the user can click on the Save icon to save a copy of the currently displayed pdf preview.



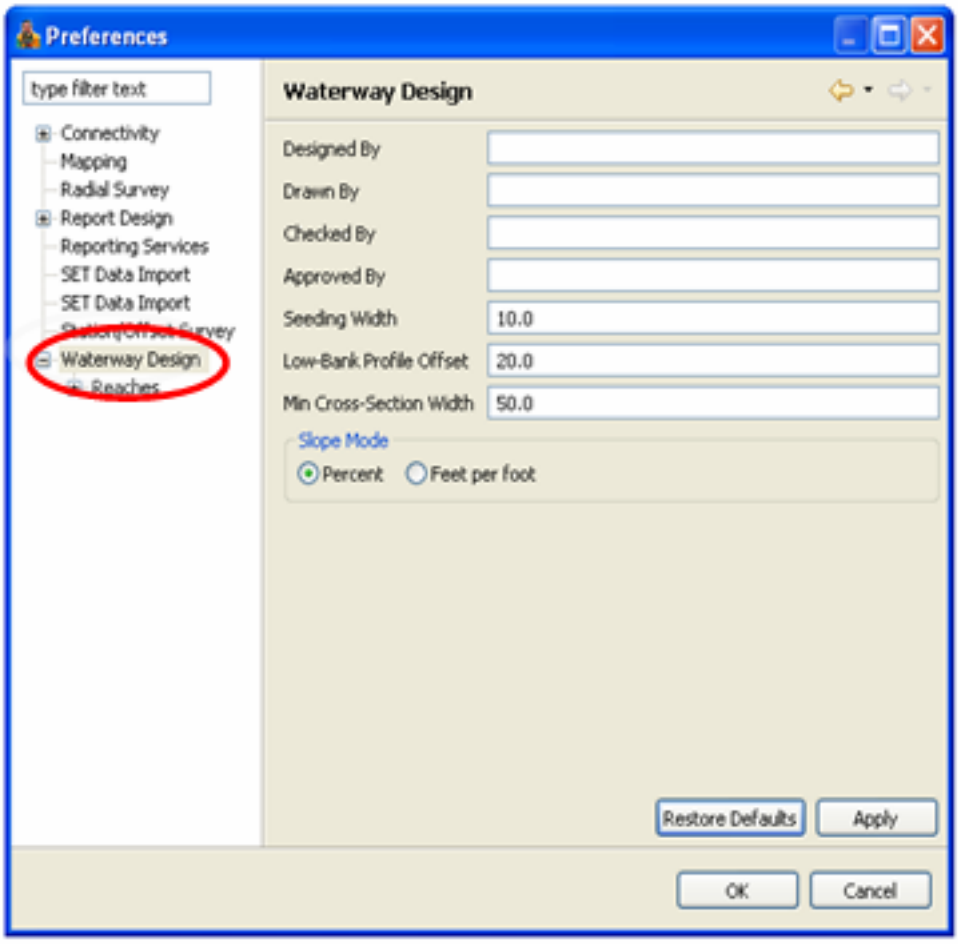
15. Preferences

There are system preferences that can be changed as described below. Access the preferences by selecting **Preferences** from the menu. Preferences for WDT are described below:

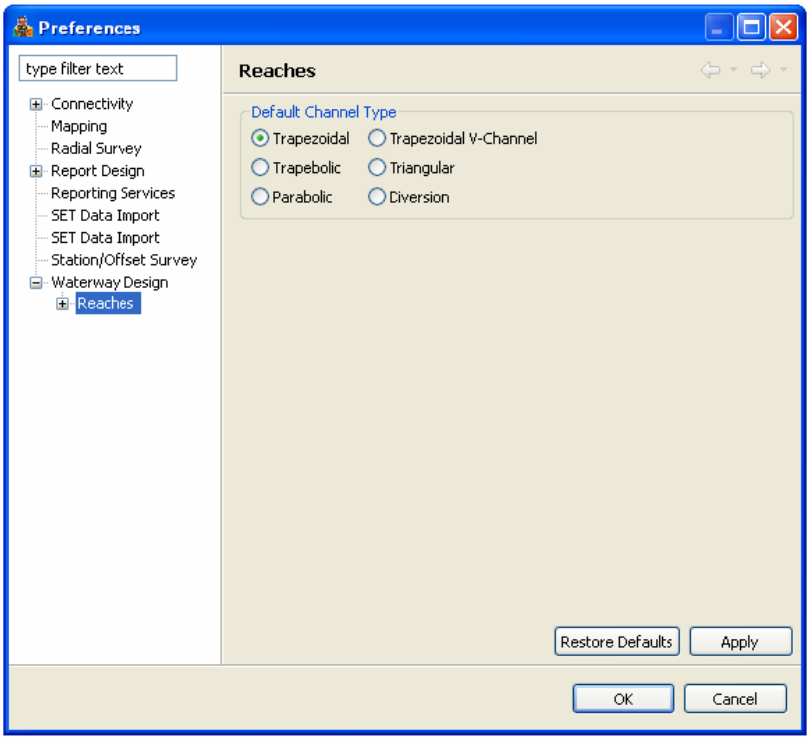


15.1. Waterway Design

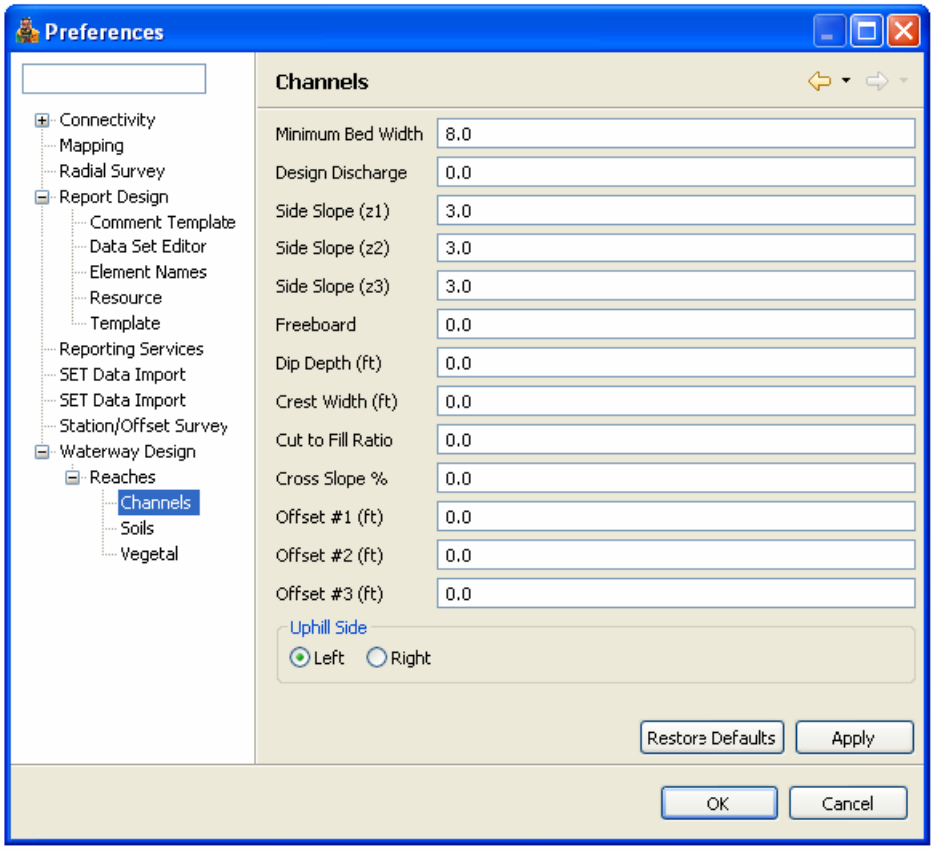
Select the **Waterway Design** option to set the defaults for WDT.



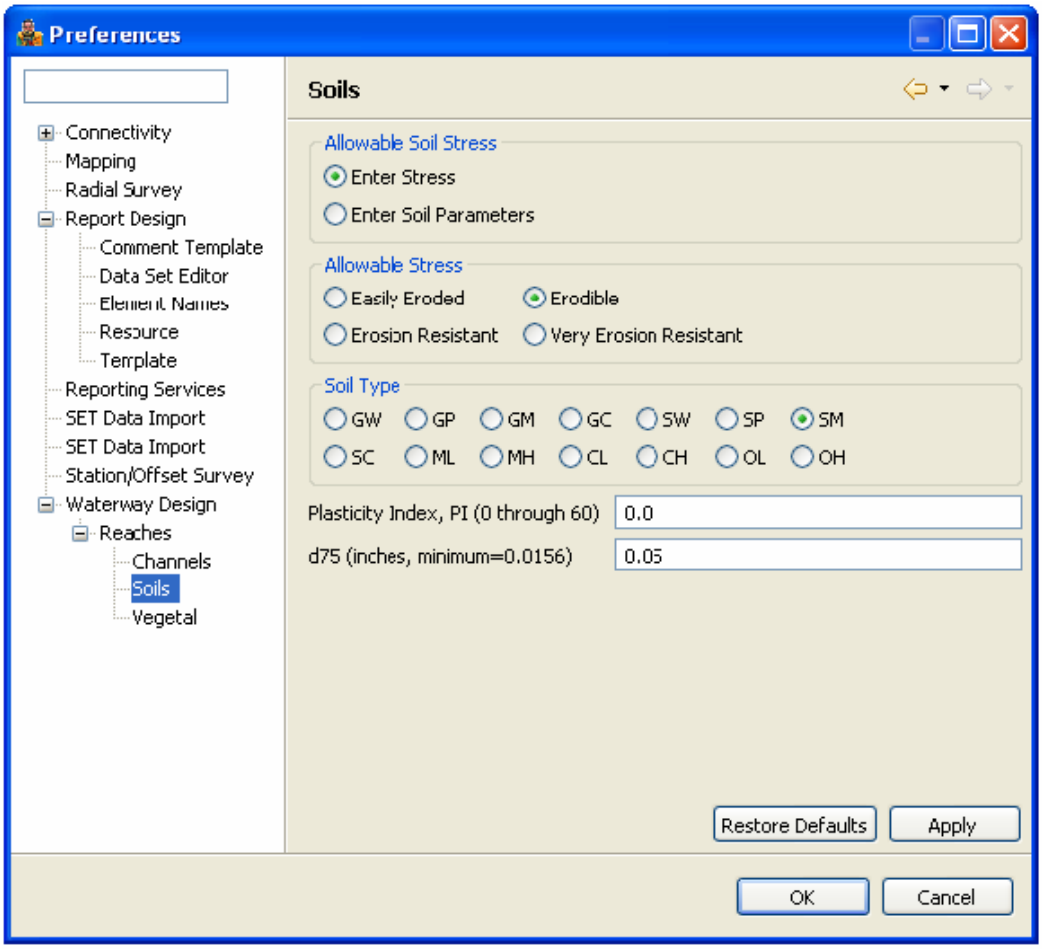
Select the **Reaches** option to choose a default channel type.



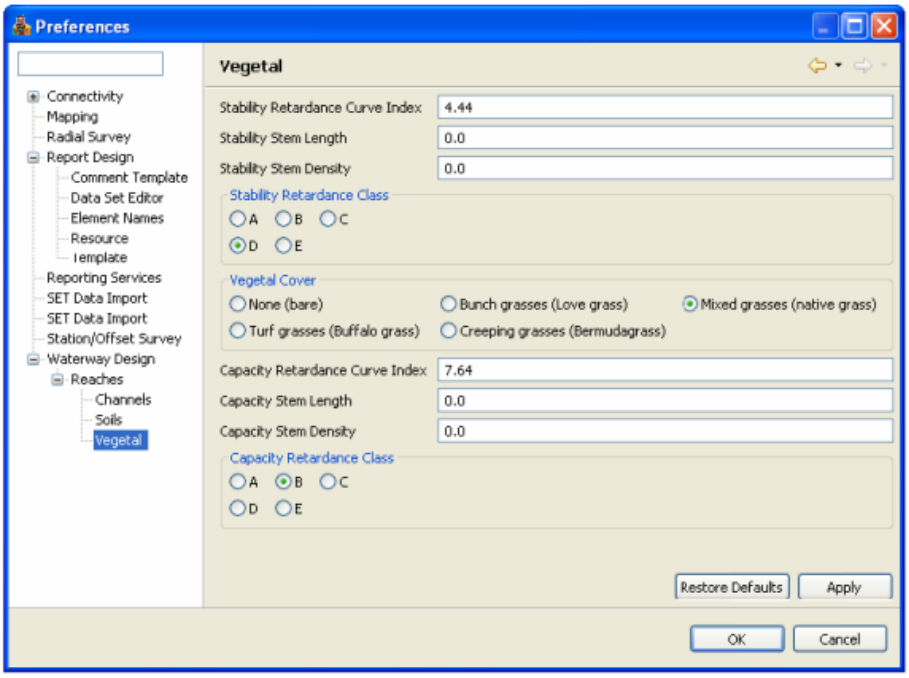
Choose the **Channels** option to set default channel parameters.



Choose **Soils** to set the default soils parameters.

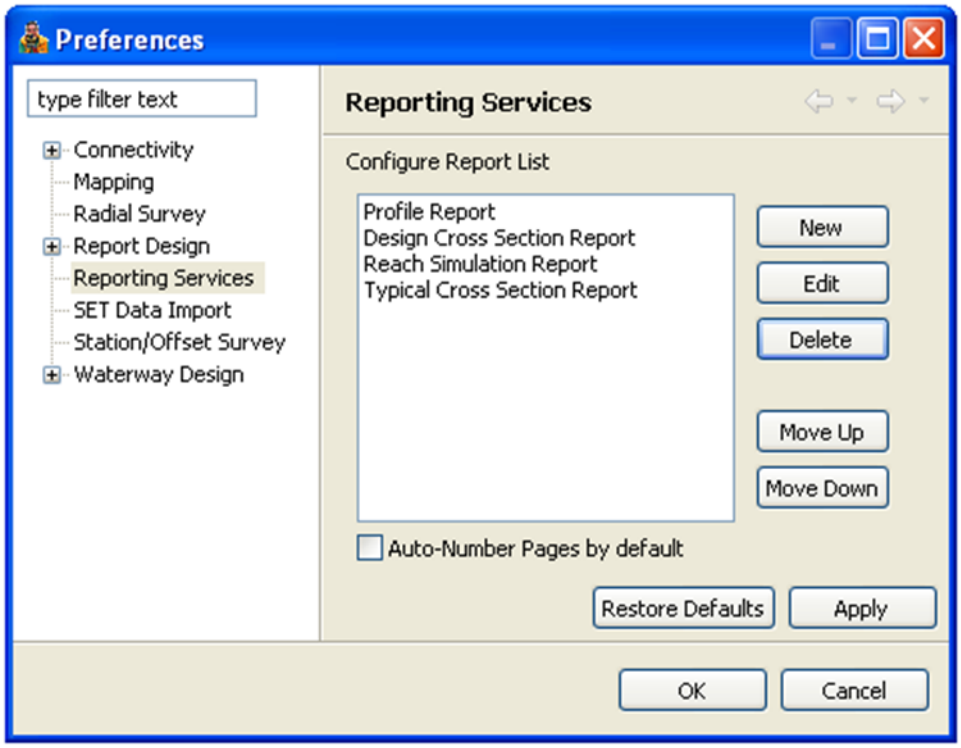


Choose **Vegetal** to set the default vegetal parameters.



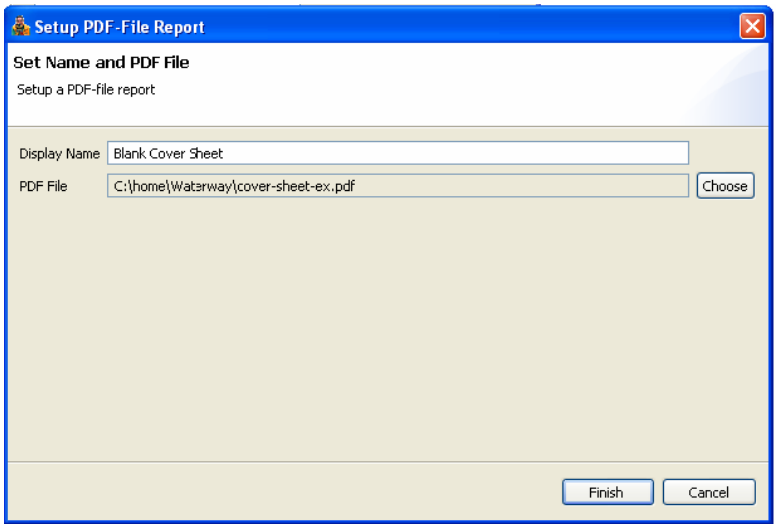
15.2. Reporting Services

Select the **Reporting Services** option to set default report pages to be printed.

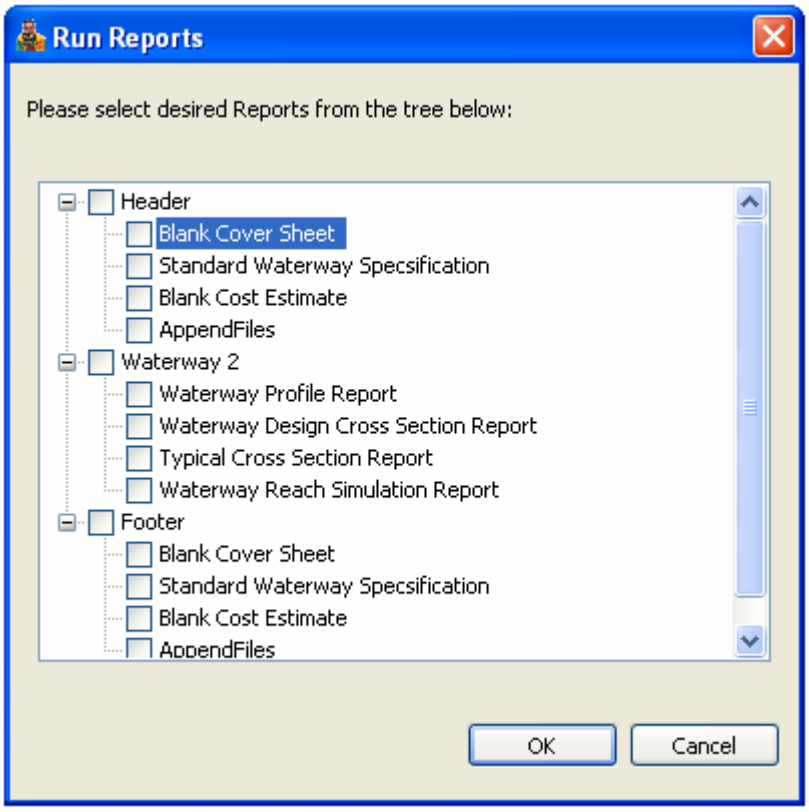


Click the **New** button to add pdf files to your default report options. Pdf files added will be available to add to reports as default options each time printing is done. At the time of report generation, an option will be available to add via AppendFiles one time pdf or image files to the report. Default pdf files are intended for standard pages that do not change for each report such as a standard Specifications page. Pdf files can contain more than one page and will be incorporated into the output report on an as-is basis. Page numbering will be the only addition to the page added. You can choose to have page numbers added by default by clicking the auto-number pages box. You will have the option to deselect page numbering at time of report generation.

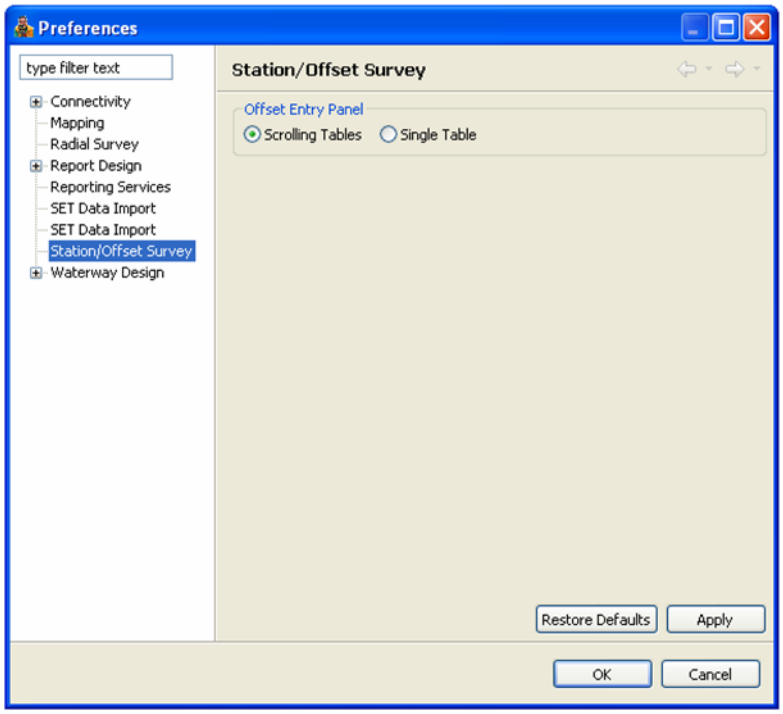
The **Move Up** and **Move Down** options allow you to control the order in which the report pages are available. Clicking the **Move Up** and **Move Down** buttons will move the selected item up or down the list. The **Edit** button allows you to change the display name or file name used and the **Delete** button removes an item from the list. The **Restore Defaults** button will reset the Report List to the original order.



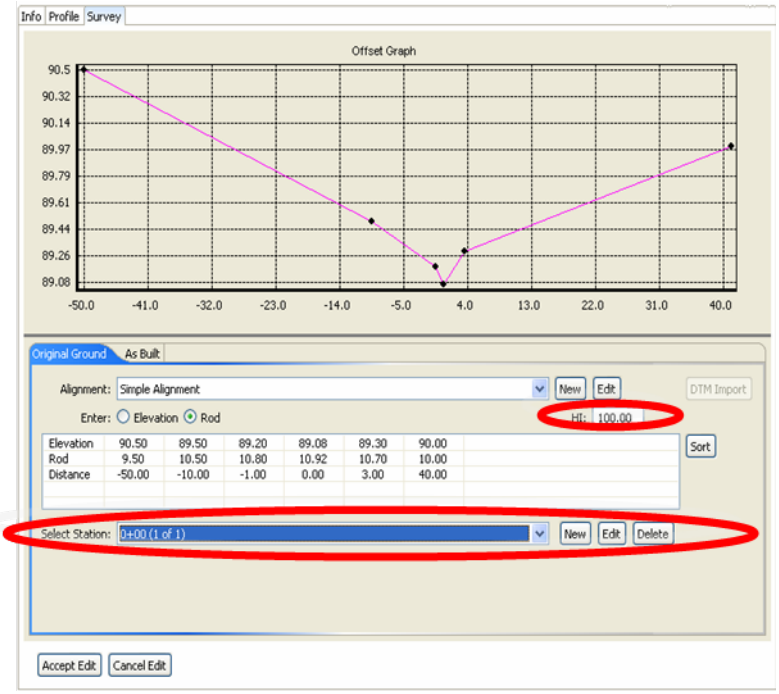
Once items have been added to the Reporting Preferences list, they become available for inclusion in reports. Items added to the report list become available in the Report Tree under both the Header and Footer sections. This gives you some flexibility as to where in the report that the added report paged are within the final report.



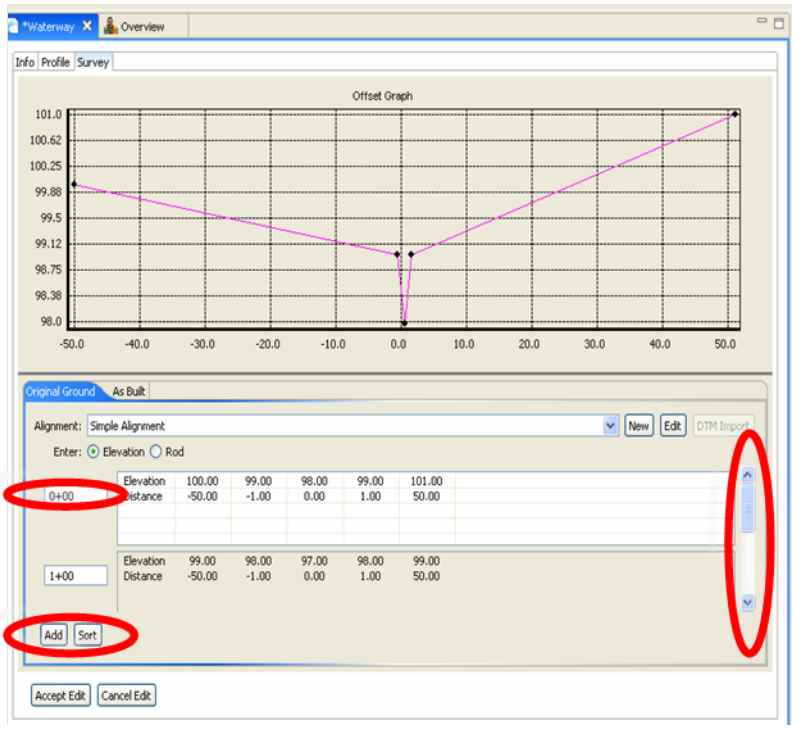
15.3. Statio/-Offset Survey



There are two different styles of Station Offset entry: the Single Table method and Scrolling Table method. The Single Table method shown below, has only one set of offset survey data on the table at a time. The user can choose from a drop down menu which station offset to edit.



The Scrolling Table method shown below, has multiple offset survey data sets on the table at a time. The user can use the scroll bar at the right to view parts of the table not currently displayed.



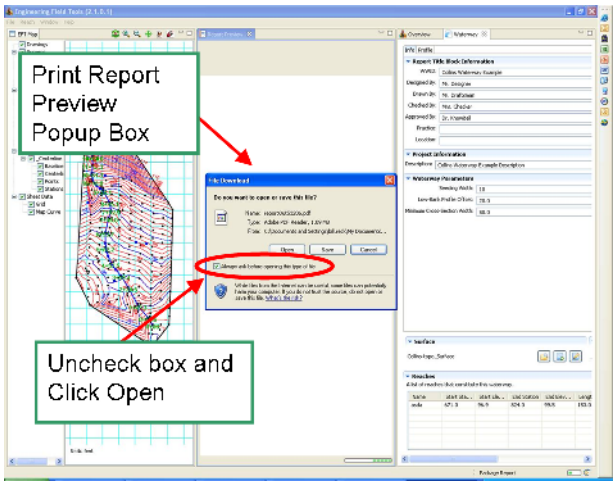
In order to change the Station Offset Entry Method, click on Windows, then Preferences, then Station/Offset Survey to select the desired entry method.

16. Troubleshooting

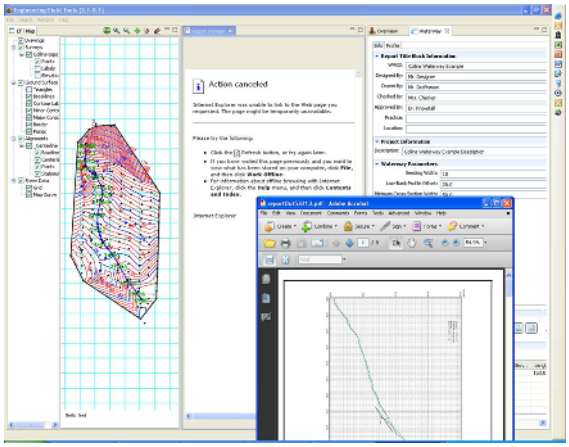
16.1. Printing Errors

16.1.1. Print Preview Fails to Display Correctly

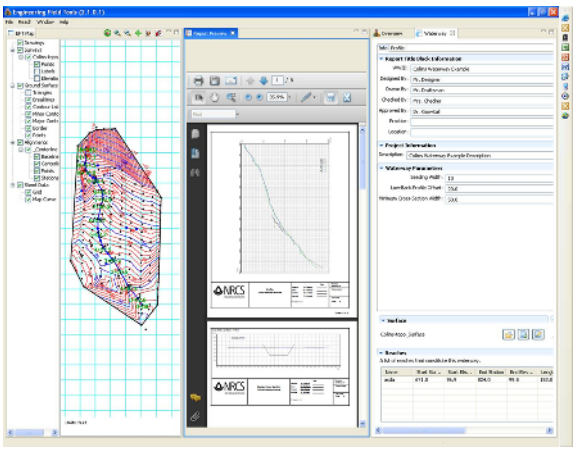
EFT creates pdf files when the user creates a report. Acrobat is used to display the report within EFT. The user may be prompted by a popup window when printing a report to either open or save the report. If the user chooses to "Open" the report, it will display correctly. Note that the user will still be able to save the report as a pdf file. If the user chooses to save the report, Acrobat will save the pdf and the report will not display within EFT. The user will be able to open the saved pdf file in a new acrobat window. In order to not have this problem, the user should uncheck the box that says "Always ask before opening this type of file" and then click the "Open" button. Then the user will not be prompted for this question again in the future.



The following image shows what happens if the user chooses the "Save" button. The report preview box displays an error message; however, an Acrobat window can still be opened as part of the Acrobat save process.

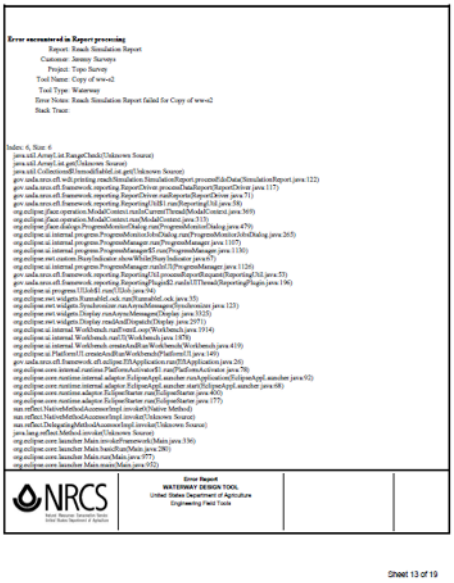


The following image shows the Report Preview tab displayed correctly. The user can select the save icon or the print icon to save or print the report.



16.1.2. Errors within the Report

When an error page is displayed within the report such as the one shown below, the most likely cause is that the report is trying to print an item that does not exist. This can happen if a file that was originally chosen for printing has been moved to another directory or deleted. It can also happen if a cross section or reach was selected in the original report selection process and does not exist when the report is again printed at a later time. EFT remembers the user's choices during the initial printing of a report. Items selected during the initial printing may no longer be valid for later printing of the report. The user should reprint the report and uncheck and then recheck all the desired reports. This will insure that only items that currently exist are printed and will eliminate this error.



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16.1.3. Newly Entered Survey does not Display Contours

When entering a new survey into WDT, the Map Graphics window will not display contours. Actually, WDT does not calculate contours until the file is saved. Once the file is saved, WDT will generate contours. When the user chooses the "Accept Edit" button when finished entering survey data, this also will trigger the software to calculate the contours.

17. Help Menu

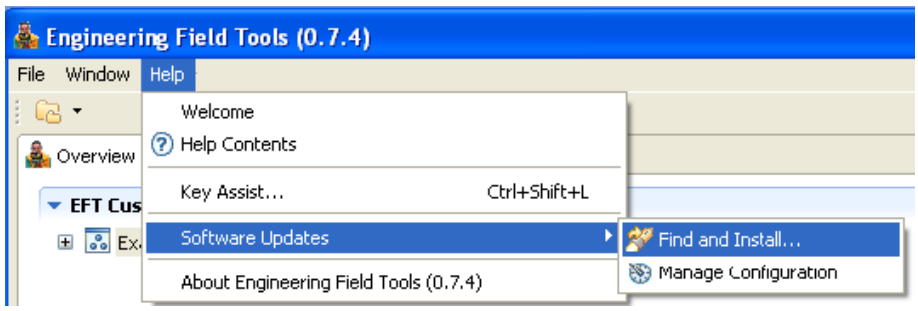
17.1. Software Updates

17.1.1. Checking for Available Updates

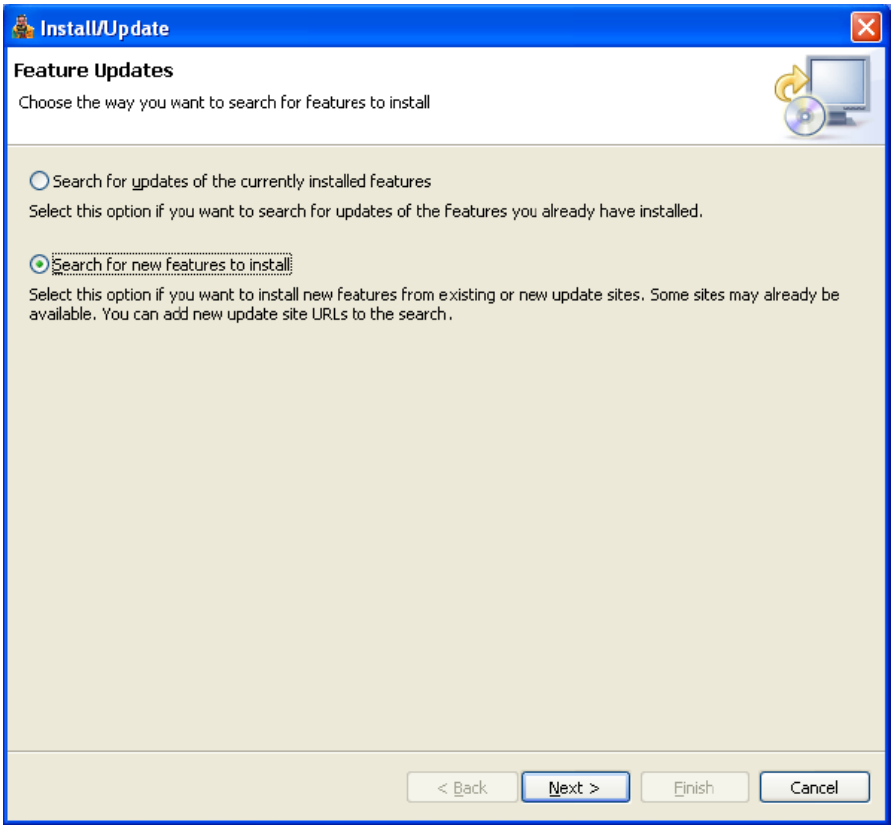
To access the update system:

1. Close all projects.

2. On the main menu at the top left side choose Help > Software Updates > Find and Install…, as shown in the screen shot below.



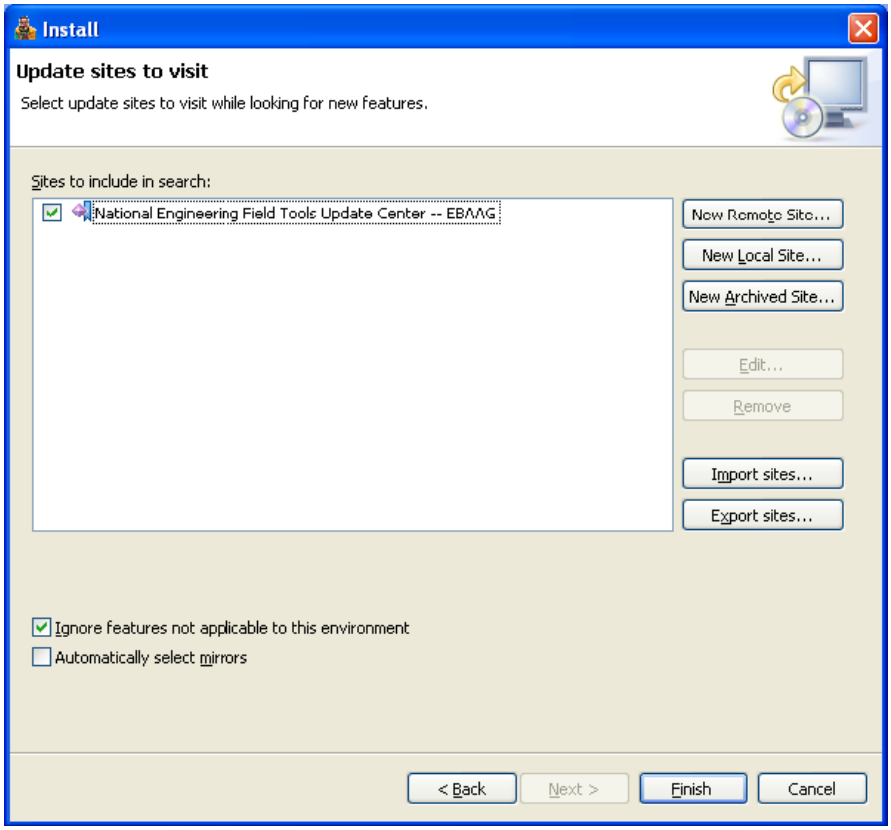
3. In the Install/Update wizard, select the Search for new features to install option as shown in the screen shot below. Then click Next.



4. In the Update site to visit page of the wizard, do the following (as shown in the screen shot below):

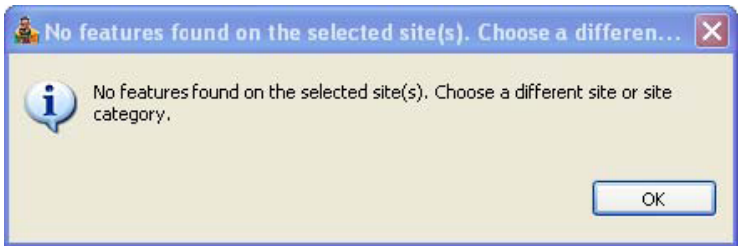
   a. click the check box next to the National Engineering Field Tools Update Center — EBAAG

   b. click the check box next to ignore features not applicable to this environment



c. Click Finish

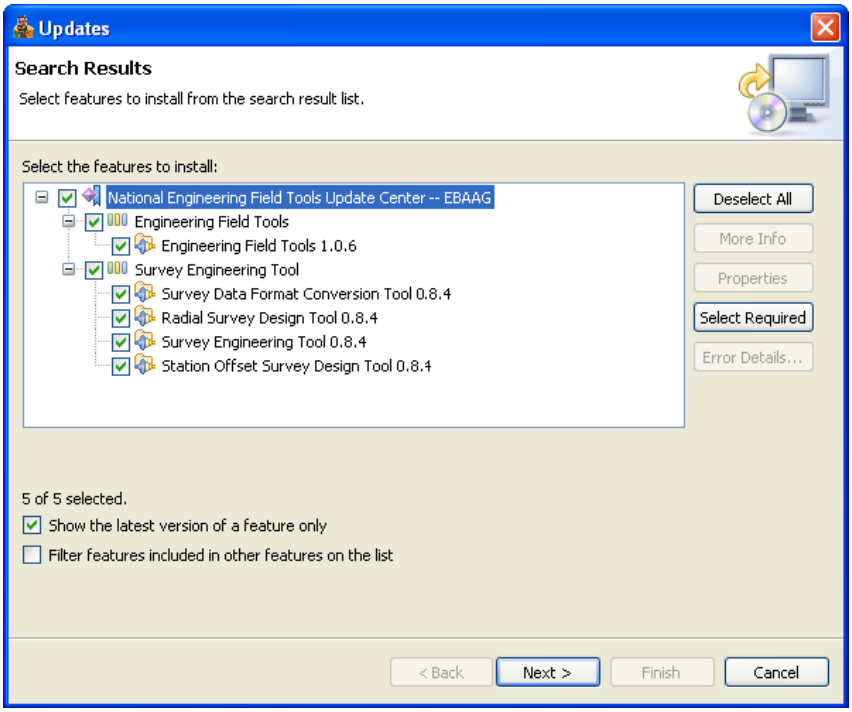
If you see the following message, then there are no updates available, and you have the latest version.



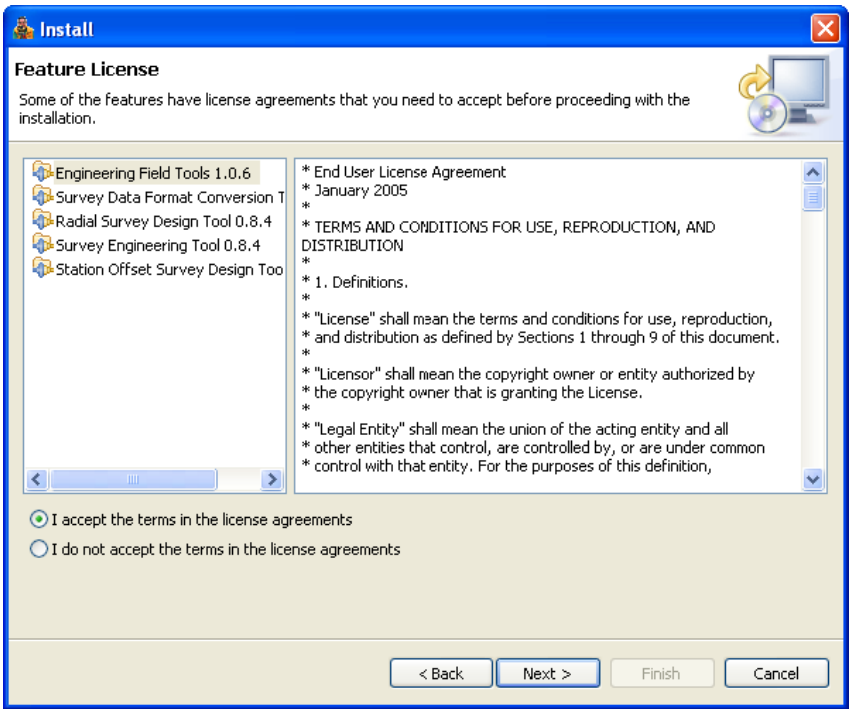
If you see available updates listed instead, proceed to the next section

17.1.2. Updating

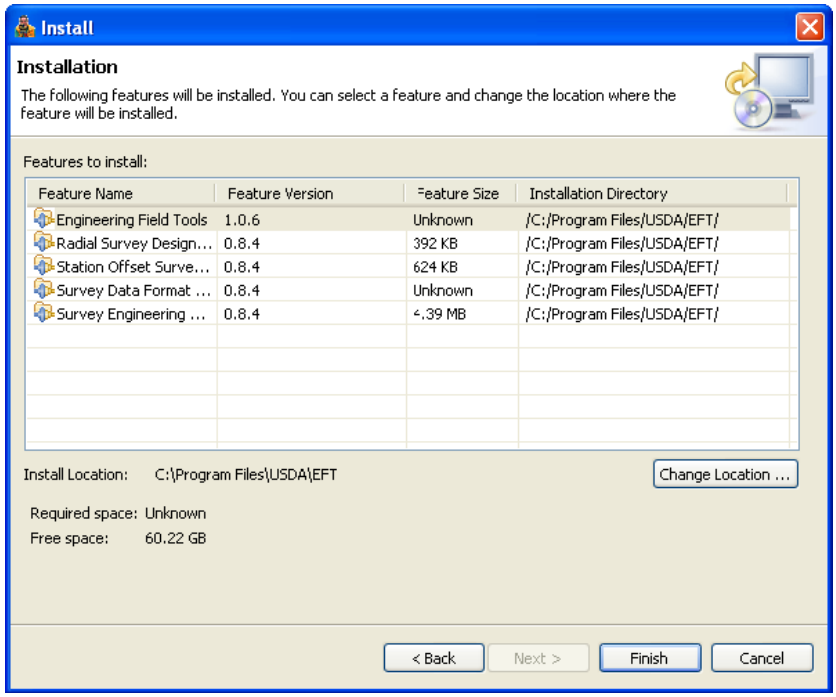
1. Shown in the screen shot below is an example list of what is available (since individual updates will differ, you may see a different list). There is the update site name followed by feature categories followed by individual feature components (with the version numbers on the right). Select the topmost checkbox and all the lower checkboxes will be checked automatically.



2. The feature license screen you should check the I accept the terms in the license agreements and then **Next**.



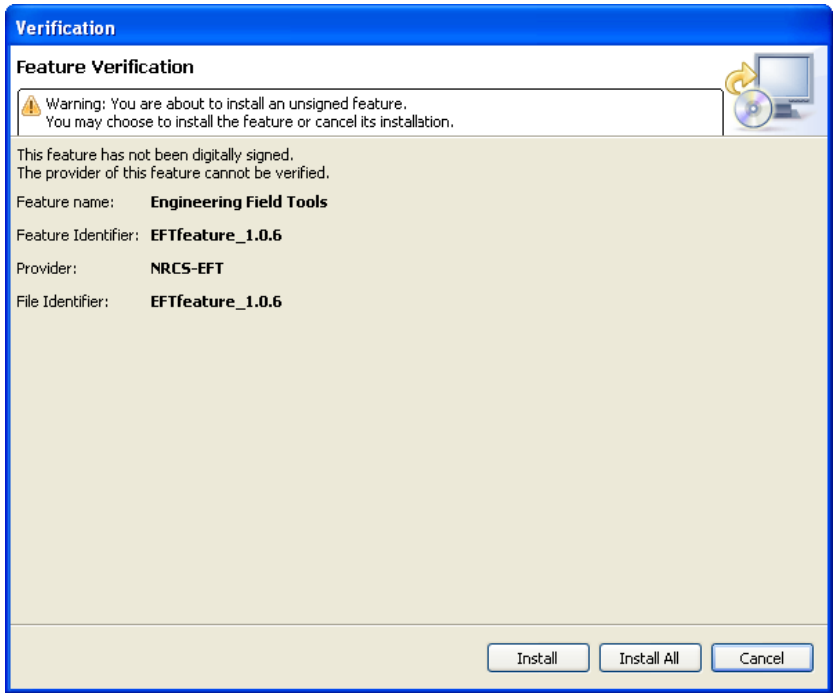
3. In the feature location screen shows file size installation and disk space availability - *please do not change the installation directory location.*



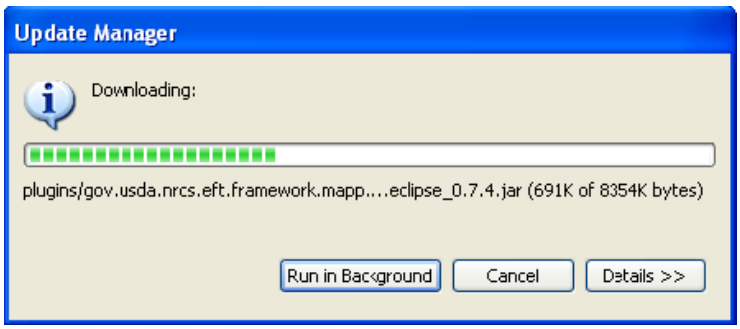
4. Click **Finish**. The update wizard will now download the update. When finished, the Feature Verification screen will appear.

17.1.3. Installing the Update

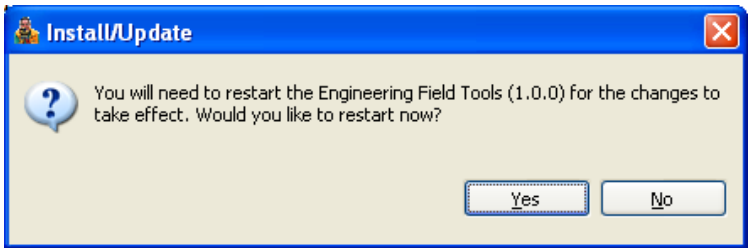
1. On the feature verification screen, verify that the provider is NRCS-EFT and install that feature; you can use the **Install_All** button.



2. Now you will see a series of downloading screens as the individual feature components are downloaded onto you local workstation.



3. With the files downloaded, they need to replace the existing versions so EFT needs to be restarted using the new features.



4. EFT will then restart with additional features added.

18. Concepts & Definitions

Arc
: An edge of a circle added to the survey map to identify the location of a natural or man made formation that has an arc shape within the survey area.

Border
: The border is defined as the outer extent of a DTM; it is made up of points (border nodes) along the outer extremities of the survey. All points contributing to the DTM must be within the border. The program develops a default border around all of the survey points. You may modify this border as needed to better represent the surface being described by the DTM

Border Node
: A point along the border that is included in the border.

Breakline
: Breaklines are lines added to the surface model to control how the triangles will be drawn, and therefore how the contours are represented. Breaklines are used to indicate discontinuity and to show a break in the slope. Triangles cannot cross breaklines, that is, a breakline will be one of the sides of the triangle between two adjacent triangles.

Contour
: A line representing equal elevation on a DTM surface.

Contour Interval
: The frequency in distance at which contour lines are shown. This setting will define the interval between all contours.

Contour Major Line Multiple
: This value will define how often major contours are displayed. Major contours are often shown in a different color and/or line weight than minor contours. This value and the Contour Interval value work together to determine how the contours will be displayed. For example, a Contour Interval of 2 with a Major Line Multiple of 5 will result in 2 foot minor contours with a major contour line at every 10 feet (contour interval of 2 multiplied by the major multiple of 5). Likewise, a Contour Interval of 5 with a Major Line Multiple of 10 will show 5 foot minor contours with a major contour line at every 50 feet.

Contour Smoothing Tension Factor
: This factor, along with the Segments per Curve, determine how smooth the contours will appear on the map. Without smoothing, the contours would show as straight line segments, without curved corners. Higher tension factors cause the contours to have tight corners, while low factors will have more broad corners. The effective range of the tension is 0 to 10, with 0 having no tension (broad corners), and 10 having the most tension (tight corners).

Convex Hull Border
: The convex hull border is the default border created by SET to contain all the points that are to be included in the DTM. It is as if a lasso was thrown around all the points and the rope was pulled tightly. All the adjacent points around the outside of the survey that the rope touches are joined by straight-line segments to form the convex hull border.

Customer
: Defines the entity for which work will be done. Each Customer contains the contact and location information for an individual customer. Customers can have multiple projects. Projects can contain multiple tools/managers.

Digital Terrain Model (DTM)
: A DTM is a representation, or model, of a surface consisting of coordinate point data. The DTM can be of the ground surface, or can be a planned surface of a structure like a pond or dam. The DTM is based on the construction of a TIN, or triangular irregular network. DTM is sometimes referred to as a DEM, or Digital Elevation Model.

Elevation
: The distance relative to a vertical datum, generally an assumed datum, or sea level.

Low-Bank Profile Offset
: The Low-Bank Profile Offset is the distance from the centerline that ground elevation is determined. The program determines whether the left or right offset ground profile is lower and plots the lower of the two elevations for each point along the profile.

Manager application
: An engineering software application, such as the Survey Engineering Tool or the Waterway Design Tool. Each specifically named manager file will have a specific "design" or "run" of the software. Alternative designs will each have a specific name.

Minimum Cross-Section Width
: This value sets the minimum cross sections width of the cross section plot.

Point
: A location in the survey that has a name, coordinates, and a description.

Point Data
: Point data are representations of a point on the surface of the DTM. Each point has X, Y and Z coordinates along with a point name and a description. Normally, point data is entered or imported as survey points collected in the field. Points can also be added manually. By default, all imported survey points will be included on the DTM. Points can be individually excluded from the DTM and can be made invisible so they do not appear on the survey map.

Point Coordinates
: All points need three point coordinates: X, Y, and Z coordinates. The X coordinate, also called the Easting, is the distance left and right (east and west) of a zero Easting datum. The Y coordinate, also called the Northing, is the distance north and south of the zero Northing datum. The Z coordinate is the elevation of the point. The three coordinates reference the point on the map in relation to other points that share the same datum.

Project
: A practice, or multiple related practices planned to be constructed at the same time, or in conjunction with each other. As an example, a Project could include a survey of a field where work will be done, a waterway,

or multiple waterways located in the field. This project could also include a diversion that drains into one of the waterways.

Reach
: Reaches are individual sections of a waterway or diversion. WDT calculates waterway design for each reach.

Seeding Width
: This is the width of seeding that will be done on either side of the typical cross section.

Segments per Curve
: Along with the Contour Smoothing Tension Factor, this affects how smooth the contours appear on the map. All contours are made up of straight line segments. To make a curve, it must be done with short segments. The more segments, the smoother the curve. Effective range is from about 3 to 100 segments per curve.

Stage Storage
: Represents the amount of storage in acre-feet, at user defined elevations relative to a virtual dam. In SET you select multiple elevation bands that terminate at the virtual dam line and the program returns the area of each elevation band and the cumulative storage in acre-feet.

Tool
: An engineering software application, such as the Survey Engineering Tool or the Waterway Design Tool. Also referred to as a Manager application. Each specifically named manager file will have a specific "design" or "run" of the software. Alternative designs will each have a specific name.

Triangular Irregular Network
: The TIN is a mesh of irregularly shaped, non-overlapping adjacent triangles connecting all points in the survey that are to be included in the DTM. Three neighboring points connected by a triangle represent a triangular face on the DTM surface. Contours are calculated by interpolating between each pair of points in each triangular face.

TINable
: Refers to points that are part of the DTM. All TINable points must be contained within the defined border to create a DTM surface model.

unTINable
: This term and nonTINable are mentioned throughout this help file. It simply means that the point is marked not TINable, referring to points that are not assigned to the DTM surface model. If surveyed points are not on the ground, and would create a false surface model, you must designate these points as not TINable, and the DTM engine will ignore them. SET will not automatically mark points "not TINable". Example of points that are commonly marked "not TINable" are bench marks. Points that exist outside of the defined border must be marked "not TINable" for the DTM to process the map. Note that points marked "not TINable" can be included in the DTM by marking them TINable again.